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PROGRAMME FOR THE OPENING DAY, MAY 10, 1876.

THE following is from the report made to the President of the United States by General J. R. Hawley, President of the Centennial Commission, giving the full programme of the opening ceremonies on the 10th of May:

Formal invitations to attend have been sent to the President of the United States, the Cabinet, the Supreme Court, the diplomatic corps, the Congress, the Government Centennial Board, the Foreign Commissioners to the Exhibition, the Governors of the States and Territories and their staffs, the Legislature of Pennsylvania, the city authorities of Philadelphia, the chief officers of the army and navy, the Women's National Centennial Committee, the Centennial Board of Finance, and others in official positions or officially connected with the work of the Exhibition.

On the morning of May 10, the grounds and buildings in general will be open to the public at 9 A.M.

The Memorial Hall or Art Gallery, the Main Building and the Machinery Hall will be reserved to the invited guests and the exhibitors until the close of the ceremonies, about noon, when all restrictions will be removed.

The exercises will take place in the open air upon the south terrace of Memorial Hall, fronting the Main Building, in full view of the general public.

Invited guests unless notified to the contrary, will enter the Main Building by way of the carriage concourse at the east end of that building, or by the south, middle, or western doors thereof. These entrances will be open to them at 9 A.M.

The music will be under the direction of Theodore Thomas, assisted by Dudley Buck, with an orchestra of 150 and a chorus of 800.

It is expected that guests will be seated in the amphitheatre prepared on the south front of Memorial Hall by 10.15 A.M.

The orchestra will play the national airs of all countries represented at the Exhibition.

The President of the United States will be escorted to the grounds by Governor Hartranft of Pennsylvania and a division or more of troops from Pennsylvania and New-Jersey, arriving about 10.30 A.M.

PROGRAMME.

1. Centennial Inauguration March, by Richard Wagner, of Germany.
2. Prayer by the Right Rev. Bishop Simpson.
3. Hymn by John G. Whittier; music by John K. Payne, of Massachusetts. Orchestral and organ accompaniment.

OUR father's God! from out whose hand
The centuries fall like grains of sand,
We meet to-day, united, free,
And loyal to our land and thee,
To thank thee for the era done,
And trust thee for the opening one.

Here where of old, by thy design,
The fathers spake that word of thine
Whose echo is the glad refrain
Of rended bolt and falling chain,
To grace our festal time from all
The zones of earth our guests we call.

Be with us while the New World greets
The Old World, thronging all its streets;
Unveiling all the triumphs won
By art or toil beneath the sun;
And unto common good ordain
This rivalship of hand and brain.

Thou who hast here in concord furled
The war-flags of a gathered world,
Beneath our western skies fulfil
The Orient's mission of good-will,
And, freighted with Love's golden fleece,
Send back the Argonauts of peace.

For art and labor met in truce,
For beauty made the bride of use,
We thank thee, while withal we crave
The austere virtues strong to save,
The honor proof to place or gold,
The manhood never bought or sold!

O! make thou us, through centuries long,
In peace secure, and justice strong;
Around our gift of freedom draw
The safeguards of thy righteous law,
And, cast in some diviner mould,
Let the new cycle shame the old!

4. Cantata, the words by Sidney Lanier, of Georgia; music by Dudley Buck, of Connecticut. Orchestral and organ accompaniment.
5. Presentation of the Exhibition by the President of the Centennial Commission.
6. Address by the President of the United States.

The declaration that the Exhibition is open will be followed by the raising of flags, salutes of artillery, the ringing of the chimes, and Handel's "Hallelujah" Chorus, with organ and orchestral accompaniment.

The Foreign Commissioners will pass into the Main Building and take places opposite their respective sections.

The President of the United States and the guests of the day will pass through the Main Building.

The Foreign Commissioners, upon the President's passing them, will join the procession, and the whole body will cross to Machinery Hall.

There, at the proper moment, the President will set in motion the great engine and all the machinery connected therewith.

A brief reception by the President of the United States in the Judges' Pavilion will close the formal observances of the day.

The price of admission is fixed at 50 cents. Persons entering are required to present a 50-cent paper piece or a silver 50-cent piece. Nothing else will be received. No tickets. Offices for the exchange of money into the above pieces are located near the gates.

On Sundays the Exhibition is closed.

BRITISH EXHIBITS.

ENGLISH SUGAR MACHINERY.

THE great lion of the English machinery exhibition is a sugar-mill made in Glasgow. The majestic solidity of the thing and its huge size make a powerful impression. Cubans and others who manufacture sugar are greatly pleased with English sugar-mills of this character, which they say are trustworthy. They stigmatize the American mills as worthless, shattering like glass at the least *contretemps*. Perhaps it would be well if those who manufacture such things would remember that the persons who run the sugar-mills are perfectly ignorant of machinery, and are very apt to abuse light and delicate things. Therefore the superfluous solidity which the English mill displays, and at which the American machinists laugh, is really correct, for the people who buy such things, and the English in suiting their wares to their customers show profound good sense. This great nation makes a fine exhibit, and so does Canada, its colony.

THE HON. J. R. HAWLEY, PRESIDENT OF THE CENTENNIAL COMMISSION.

LOCOMOTIVE CRANES.

Messrs. Appleby & Co., of England, exhibit several of their admirable locomotive cranes, and fine specimens of mechanical work they are. They have been practically useful in lifting goods into their places; the ease with which they ran about the grounds wherever wanted being quite marvellous.

The general appearance is something like a locomotive engine, without the cab for the engineer and the fireman. It is a self-propeller, and used for the purpose of clearing away wrecks and lines of railway in case of collision or other accident. At the end farthest from the engine there is an arm of heavy timber, to which are suspended chains, hooks, blocks, and tackle. The peculiarity of the machine is that it is self-acting; the arm revolves on a pivot near the front, it hoists and lowers about three tons weight, and is driven by a pair of six-inch cylinders. The wheels are joined by connecting-rods, and the usual propelling gearing. In order to insure steadiness in the lifting power, in front of the wheels there are patent "clutches," which are under the control of the engineer, intended to take hold of the track, and prevent slipping along the rails. Each machine is valued at about $500.

ENGLISH PRINTING PRESSES.

The famous Walter press is exhibited by its inventor, the proprietor of the London *Times*. It is a magnificent specimen of work, made mostly of steel, polished and shining to the highest degree. This press is capable of printing some 20,000 large newspaper sheets per hour.

GENERAL INFORMATION FOR VISITORS TO THE EXHIBITION.

THE Centennial Commission notify the public—

	Guests.
That the hotels of Philadelphia will accommodate above the present regular occupants	15,000
The Centennial Lodging House Agency	20,000
Accommodation by relatives and friends	40,000
Boarding-houses	13,000
Patrons of Husbandry (for grangers)	5,000
Camp Scott (for military organizations)	5,000
Camp in Fairmount Park (for Military)	5,000
Suburban hotels	20,000

There is no doubt of Philadelphia being able to entertain, if necessary, at reasonable prices, 150,000 persons, and, if further pressed, to comfortably lodge and care for 200,000 persons. Hotel prices from $3 to $1.50 per day. Boarding-houses from $1 to $2.50 per day. Centennial Lodging-House Agency, lodgings, $1.25 per day; breakfast, supper and lodgings, $2.50 per day.

Patrons of Husbandry Camp, at Elm station, will accommodate 5000 persons of that order at $1.50 per day; three miles by Pennsylvania Railroad from Exhibition grounds. Fare, round trip, fifteen cents. Address V. E. Piolette, Elm station, Pennsylvania.

Camping ground for military organizations in Fairmount Park (under the laws of Pennsylvania), near Exhibition grounds. Address Adjutant-General J. W. Latta, Harrisburg, or General J. R. Hawley, President U. S. C. C., Philadelphia, Pa.

Camp Scott, for civic and military organizations, one mile from Exhibition; fare same as street-car rates. Horses cared for and furnished, and meals provided. Postal and telegraphic facilities. Address Colonel J. V. W. Vandenburg, Camp Scott, Philadelphia, Pa.

As an instance of the preparations for the accommodation of visitors, the Centennial Lodging-House Agency is mentioned. It has rooms for 20,000 guests, which can be increased to 30,000. Tickets for lodgings and meals will be sold at all important points in the country, and on all passenger trains approaching Philadelphia.

Persons who have purchased such tickets will be furnished a card by the train agent, assigning them to proper quarters. This agency is in the hands of competent managers. Address William Hamilton, General Superintendent, No. 1010 Walnut street, Philadelphia, Pa.

By steam and horse cars, with present facilities, 20,000 persons per hour can reach the Exhibition from any part of the city of Philadelphia. If it is necessary, 40,000 persons per hour can be moved. Fares, six and a quarter and nine cents.

The Exhibition Transfer Company, Limited, whose agents will be on all passenger trains, will transport, by carriage, passengers within limits of four or five miles for fifty cents each; baggage at like reduced rates. Hundreds of hack, carriage and omnibus companies, as well as private individuals, will perform the same service at same rates.

One minute after the arrival of trains on all main lines entering Philadelphia passengers can be within the Exhibition. We confidently expect that during the year the railroads of the United States will make such further reductions in their rates as will enable every person who desires to visit the Exhibition at a very small expenditure, and thus put the opportunity within reach of all. Incidentally we note, as an evidence of this, the fact that the Pennsylvania Railroad has ordered a train between New York and Philadelphia at the rate of $2 for the round trip.

The sanitary condition of Philadelphia is good; rational amusements have been provided; arrangements for protection from fire, thieves, &c., are as nearly perfect as is possible in a great city. Within the Exhibition every precaution has been taken for the safety, comfort, happiness and pleasure of the public.

ELECTRICAL VISITORS' REGISTER.

BY an ingenious contrivance of W. S. Phillips, Superintendent of the telegraph, every one of the eighty turnstiles set at the several entrances of the Exhibition grounds are connected by wire with a dial in the main office of the Centennial Commission. When a person enters through a turnstile, he is instantly registered on this dial. At any instant of the day, therefore, it will be possible to know, by glancing at the dial, the exact number of people who have passed the gates, and are within the Exhibition grounds and buildings.

THE JURORS AT THE EXHIBITION.—A change has been made of late in the jury plans, by which the number of American jurors is increased from 100 to 125, and their compensation cut down from $1000 each to $600, the number of foreign jurors remaining at 100, and their salary at $1000.

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FORMULA FOR LUNES.

RECENTLY while making some investigations on the flow of water under various circumstances through conduit-pipes, it became necessary for me to find the area of the lune formed in a pipe by the interposition of a circular valve which constricted its XX; the only data being the radii of valve and pipe, and distance *s* which the valve protruded into the latter. Being unable to find a formula applicable to the case, and therefore obliged to deduce one, it seemed to me that, although very simple, it might be of use to others who have little time for investigation. Indeed, I know of one case where a practicing engineer, in default of a suitable formula, was forced to draught the lune of full size, and then, by superposition of ruled paper, find the number of square inches it contained.

I enclose the demonstration, which, so far as I know, is original.

TO FIND THE AREA OF A LUNE.

In the Fig. let the small circle represent a section of the pipe with radius = A C, and the larger one the valve with radius = A C′; F G is the distance which they overlap, and A D the common chord; A C E is half the angle subtended by A D at C, and A C′ E the corresponding angle at C′.

It is required to find the area A B D F.

Let A C = r, A C′ = r', F G = s.

Also C E = x, C′ E = x', A C G = $\frac{1}{2}a$, A C′ F = $\frac{1}{2}a'$, y = G E, and y' = F E.

Then C C′ = $x + x' = r + r' - s = b$. (1.)

Also in triangle A C E, $x^2 = r^2 - (AE)^2$

and " " A C′ E, $x'^2 = r'^2 - \overline{AE}^2$

and by subtraction $x^2 - x'^2 = r^2 - r'^2$. Now factoring $(x + x')(x - x') = r^2 - r'^2$, and from value of $x + x'$ in Eq. (1.)

$$x - x' = \frac{r^2 - r'^2}{b}. \quad (2.)$$

Adding (1) and (2), we have: $2x = \frac{r^2 - r'^2}{b} + b$; whence

$$x = CE = \frac{r^2 - r'^2 + b^2}{2b}.$$

We may now have three cases:

I. If $s > r$; then F G = $s - r$

whence versin $\frac{1}{2}a' = y' = x + FC = x + s - r =$

$$\frac{r^2 - r'^2 + b^2}{2b} + s - r = \frac{(r-b)^2 - r'^2 + 2bs}{2b}. \quad (3.)$$

II. If $s = r$; F C = o,

$$\text{versin } \tfrac{1}{2}a' = y' = x = \frac{r^2 - r'^2 + b^2}{2b}. \quad (4.)$$

III. If $s < r$; F C = $r - s$,

$$\text{versin } \tfrac{1}{2}a' = y' = x - FC = \frac{(r-b)^2 - r'^2 + 2bs}{2b} \quad (3)$$

as in case I.

From eqs. (3) and (4) we can, then, always find the versin $\frac{1}{2}a'$. Versin $\frac{1}{2}a = y = s - y'$.

Then we find a and a'; compute the segments A F D and A G D by the formula:

$$S = \tfrac{1}{2}\,(.01745329\, r^2 a - r^2 \sin a \quad (5)$$

(where S = area of segment; a = angle at centre in degrees, and r = radius), and their sum subtracted from A B D G (= πr^2), will give the area of the lune required.

If the slide-valve is of the same radius as the interior of the pipe, then $r = r'$ and $y = y' = \frac{1}{2}s$. Then we find either segment, double it, and subtract from A B D G.

AREA OF SEGMENT.

Formula (5) is thus found:

Let A F D be the segment whose area = S. Then

S = A F D C′ − A D C′. But A F D C′ = $\frac{r' \text{ arc A F D}}{2}$ =

$\frac{r'^2 a'^\circ}{2} \cdot \frac{\pi}{180^\circ} = \frac{1}{2} r'^2 a'^\circ .01745329$, and A D C′ = $\frac{r'^2 \sin a'}{2}$;

whence we derive (5).

G. B. W.

ITHACA, N. Y., April, 1876.

THE DEPTH OF THE SEA.

AT the last meeting of the Royal Society, Mr. Siemens, D.C.L., F.R.S., exhibited the instrument he has devised to ascertain the depth of the sea by a new means without using a sounding line. He has worked out the requirements, starting with the proposition that the total gravitation of the earth as measured on its normal surface is composed of the separate attractions of all its parts, and that the attractive influence of each equal volume varies directly as its density and inversely as the square of its distance from the point of measurement. The density of sea water being about 1.026 and that of the solid constituents composing the crust of the earth about 2.763 (this being the mean density of mountain limestone, granite, basalt, slate, and sandstone), it follows that an intervening depth of sea water must exercise a sensible influence upon total gravitation if measured on the surface of the sea. Mr. Siemens showed how this influence can be proved mathematically in considering, in the first place, the attractive value of any thin slice of substance in a plane perpendicular to the earth's radius, supposing that the earth is regared as a perfect sphere, of uniform density, and not affected by centrifugal force. It was in 1859 that Mr. Siemens first attempted to construct an instrument based on these principles. The difficulties he then encountered he has since overcome, and the present instrument is the result of his latest work. He proposes to call it a bathometer, and it consists essentially of a vertical column of mercury contained in a steel tube having cup-like extensions at both extremities, so as to increase the terminal area of the mercury. The lower cup is closed by means of a corrugated diaphragm of thin steel plate, and the weight of the column of mercury is balanced in the centre of the diaphragm by the elastic force derived from two carefully tempered spiral steel springs of the same length as the column of mercury. One of the peculiarities of this mechanical arrangement is that it is parathermal, the diminishing elastic force of the springs with rise of temperature being compensated by a similar decrease of potential of the mercury column, which decrease depends upon the proportions given to the areas of the steel tube and its cup-like extensions. The instrument is suspended a short distance above its centre of gravity in a universal joint, in order to cause it to retain its vertical position, notwithstanding the motion of the vessel; and vertical oscillations of the mercury are almost entirely prevented by a local contraction of the mercury column to a very small orifice. The reading of the instrument is effected by means of electrical contact, which is established between the end of a micrometer-screw and the centre of the elastic diaphragm. The pitch of the screw and the divisions upon the rim are so proportioned that each division represents the diminution of gravity due to one fathom of depth. Variations in atmospheric pressure have no effect on the reading of the instrument, but corrections have to be made for latitude. The instrument has been actually tested in voyages across the Atlantic in the Faraday, and the comparisons with Sir W. Thomson's steel wire sounding apparatus showed it was very reliable. The paper concluded in pointing out many ways in which the instrument might be of use; among others was that of indicating approaching danger if contour lines were first efficiently mapped.—*London Times.*

BESSEMER PROCESS—IRON DIRECT FROM THE BLAST-FURNACE.

THE annual meeting of the Iron and Steel Institute took place at the Westminster Palace Hotel on the 28th of March, under the presidency of Mr. W. Menelaus, of Dowlais.

The PRESIDENT said that the council had had under its consideration for some time the question whether some mode could not be devised for introducing interesting subjects to the Institute in a more easy method than the writing of a paper, and they had determined to make the experiment today. Mr. J. F. Smith, of Barrow, had undertaken to start it by telling his experience on what, perhaps, was the most interesting subject that could possibly come before the Institute at the present moment—namely, the use of iron direct from the blast-furnace in the Bessemer process.

Mr. SMITH. The subject of running molten iron direct into the Bessemer converter from the blast furnace has twice before been raised before this Institute. On the first occasion, at Barrow, there were some remarks made in the discussion by various gentlemen, of whom I unfortunately was one, and I think the views so expressed would have been materially modified had we known more of the practice which even at that time was going on abroad. In a largely-developing industry like that of steel, as well as that of iron, I do not see why there should be any diffidence in expressing that we have been lying under errors, because if we acknowledge improvements, it certainly carries the fact with it that we have been in error before. On the second occasion the discussion arose upon an interesting paper with respect to the works at Seraing, and I am glad to be able to testify to the value of that paper, as also to the courtesy with which upon two occasions I have been received at Seraing, when I have been there to watch the process. The discussion that succeeded that paper, or a large portion of it, ended in inquiring what could be done with the pig-iron between Saturday afternoon and Monday morning. I think the impression must have been made upon the minds of members that it was necessary to place the Bessemer converter in close contiguity to the blast-furnaces. But, sir, when I went abroad and saw what they were doing there, I found that in no instance was the furnace nearer, perhaps, than 40 yards, and in some instances at least 200 yards off. In those places where the hundreds of yards prevailed, the ladle was drawn by horses to a lift, and even in all cases—Seraing being the most perfect—a lift is used to raise the ladle containing the molten iron taken from the blast-furnace to the platform from which the Bessemer converter is to be charged. In watching the time that this charge took, it appeared to me that there should be no difficulty found in works like ours, where the blast-furnace and the steel-works are separated by a main line of railway. In consequence of having to cross that line of railway at a convenient and safe point, it was necessary to convey the molten metal from one and a half to two miles. All the gentlemen here will readily believe that a couple of miles, or even five miles, when you have a locomotive before the ladle-carriage, is not of very much moment, especially as I can assure you that the cooling process that takes place within the first hour of the iron being put into the ladle is really very small indeed. There is no difficulty whatever in arranging new works so that the iron can be run into the ladle for the Bessemer, or into the pig-bed, at pleasure. In our case we have made a railway cutting at the foot of the pig-beds, and an incline at the end of the steel-works, so that the locomotive draws the carriage containing the ladle from the pig-beds, runs from one and a half to two miles, backs the ladle up to the converter, and discharges it, and takes the empty vessel back again; and when every thing is prepared for it, this is done in half an hour. But as sometimes the converter is not ready to receive the iron, or occasionally we are interrupted in crossing the railway, we have regulated the time of the trains to be exactly one hour, and our trains have for the last six months run night and day, each time taking the two ladles of seven tons each. It will be seen that the cost of the transit of molten metal a couple of miles, each engine representing something like the conveyance of a thousand tons a week, is not a very serious matter. In fact, we really convey the molten iron more economically than we used to put the pigs into wagons and unload them again at the converter. The result of the operation in the converter was, of course, a subject of great interest to all of us, as, after all, when we bring the molten metal from the furnace, and intend to make good steel, really the steel manipulation is of secondary importance. The real value is in the manipulation in the blast-furnaces, and you have to send iron of exactly a suitable quality for the Bessemer process. And even, indirectly, in this way I consider we have derived some very considerable advantage, because I am satisfied that we have had our furnaces better managed since these operations took place than we had before. And this is not an idle boast when I say that two of the furnaces that were assigned to supply the steel-works with molten metal have never missed one single cast for the last six months. And having, of course, to take a very much larger quantity of iron across than is represented by two furnaces, I consider that our customers who buy the rest of the pig which we make have the advantage of the mixing of ores, thus caused by our having to use a large quantity of iron ourselves. Every body knows that to make good steel properly it must be made with great regularity. The practical difficulties we have to deal with in doing this have been very small indeed, and I often wonder why our minds were so embarrassed that we did not begin the operations sooner.

Mr. RICHARDS said that at the Ebbw Vale Works they had been very successful in making steel from iron taken direct from the blast-furnace. The molten metal had to be taken three quarters of a mile over a bad road and steep gradients, but the result had been very successful. They had worked daily, and had got five casts, of four tons each cast, without any trouble or difficulty whatever. On one occasion the converter was not ready to receive the metal, and the iron had to remain in the ladle for a whole hour, but with the exception of its running a little thickly into the converter there was no loss, and they had a most successful blow. It was found, in tapping the blast-furnace, that a sufficient quantity of slag ran out and formed a crust on the surface of the metal, and that crust prevented the metal from slopping over, even when it was run at ten miles an hour down a gradient of 1 in 30. He should have no hesitation in saying that the molten metal might be taken in the ladle for two miles, if necessary, before being put into a converter, but still it would be well to have the blast-furnaces and the converter as near as possible.

Mr. SNELUS said that he had been working for some time with the metal direct from the blast-furnaces. At first he was delayed by difficulties connected with the carriage, but for the last three weeks they had been working continuously. He had only three blast-furnaces, and the make of them was not very large. Last week they used 450 tons of metal direct from the furnace, and the yield was 83¼ per cent of ingots and barely 2¼ per cent of scrap, including the ladle-skulls. He was speaking entirely of the iron scrap. About half the scrap was ladle-skulls, and the remainder was the raking out of the ladles. One ladle did thirty-eight casts without relining. They took six-ton charges, and had to run the ladle 700 yards round a very awkward road. It was then placed upon a hydraulic lift, which at the same time lifted the ladle-carriage and turned it round ready for turning into the vessel. He was now engaged in making a better road to the converters, and he was making a new carriage in which the ladle would be in the centre and no balance weight would be required. It was gratifying to him that the process was successful, but he agreed with Mr. Richards that it was necessary to watch the amount of silicon, and not to let it run so high as formerly, for the silicon caused a great waste of iron. He agreed with what had been said about the necessity of working regularly. Notwithstanding all the care that could be taken with a blast-furnace, he thought it advisable not to take the iron entirely from one furnace. In order to get an average mixture they ought to take the metal from at least two furnaces. They had done that without difficulty at his works; and the whole operation, from the time of tapping the first blast-furnace to the time of making a finished rail between 60 ft. and 70 ft. long, weighing 80 lb. to the yard, occupied only one hour and nineteen minutes.

The PRESIDENT said that it would be of interest to know how long it required from the moment they began to tap the first furnace until they got the metal into the converter—that really was the point.

Mr. SNELUS said that it took about twenty minutes to tap two furnaces, to get out the iron out, and to take it to the vessels. It took some time for the iron to run into the ladles. The closer the ladle could be got to the furnaces, the better.

Mr BESSEMER.—I think after what has been said that there is scarcely room for an observation. However, I may at least say that I am exceedingly gratified to hear the account from those three gentlemen to-day of the working of my process with iron direct from the blast-furnace. The earliest idea I ever entertained of the process was that we should never remelt the iron, and it was only because I had not access to a blast-furnace in my experiments that those experiments were made with pig iron. No doubt I had a good deal of advantage in that fact, because I availed myself of that very point of advantage which the last speaker has dwelt upon, and I was enabled to select the metal. In my earliest experiments I happened by a great chance to buy some excellent Blaenavon iron, and I got a result so satisfactory with that particular batch of iron that I was ready to conclude that every kind of iron throughout the kingdom would answer the purpose. The very next kind of iron that I tried was that produced by our friends at Dowlais, and I need not tell you that they were making a material not suited to my purpose. I can assure you that turning from the one of those metals to the other was the greatest blow that I ever received. My fine-spun theory, that all iron would answer the parpose, was knocked in the head in an instant, and it took me something like two years to recover from that blow. To return to the subject which has been last spoken of, I must say that I am exceedingly gratified to see that it has been found practicable in England to work iron direct from the furnace in my process. I have thought to try myself the tapping of three blast-furnaces; and when I advised some of my friends in the neighborhood of Barrow to go into the steel-making, they did arrange their works, some two or three years ago, so that pig-iron might be tapped into a spherical vessel, with a close top, to hold twenty tons. It was resolved to make three seven-ton tappings, and to have a second vessel so as to keep on continuously, and to keep the heat up and avoid skulling in the transit. In fact, it was intended to work by very similar means to those which these gentlemen appear to have used. I may say how exceedingly gratified I am to find that my earliest ideas have been brought, so far, to a favorable issue.

Mr. GARBUT said that he believed that Mr. Bessemer, in his paper which was read before the British Association, claimed the idea of dealing with the iron direct from the blast-furnace, and the suggestion made a great impression at the time, and many resolved to try it.

FERRO-MANGANESE—MANUFACTURE OF STEEL.

By M. F. GAUTIER.*

THE use of specular pig-iron—or spiegeleisen, as it is termed in Germany—has been a great success in the Bessemer process. For some time after spiegeleisen was first employed, its addition was merely regarded as a re-carbonizing agent, which was rendered necessary on account of the protracted refining; the required hardness was obtained by the admixture of a pure and highly carburetted pig-iron, without taking into consideration the part which manganese might play in the operation. Thus steel-manufacturers selected their spiegel iron on account of its good and more or less foliated appearance, as this description of pig-iron was alone capable of imparting to steel that body which had been eliminated by the protracted blowing. Notwithstanding that there were other pig-irons which contained a sufficiency of carbon, it was at length found that manganese was the agent contained in the spiegel, which answered the purpose required.

In 1866 M. Valton, who then conducted the steel-works at Terre-Noire, expressed his views relative to the reducing properties of manganese in the *Bulletin de la Société de l'Industrie Minerale de St. Etienne.* He was of opinion that the iron oxide with which the Bessemer metal was saturated at the end of the process, was magnetic oxide, and not peroxide. He concluded that this was the case because of the high temperature employed.

The magnetic oxide, having only the same affinity to silicon as peroxide, does not come away with the slag, but remains in the pig-iron, and thus makes it red-short and unfit for rolling. If, however, we add, in the form of spiegel, metallic manganese—a body which takes up oxygen more readily than iron—the oxide of iron is converted from the steel bath into a state of protoxide, and the silicon takes up this to form slag. The reaction is represented by $Mn + Fe^3 O^4 = 3\,FeO + MnO$; and the manganese is also combined with the slag.

Recent improvements in the method of ascertaining the proportion of manganese in iron—a chemical problem which at one time could not be solved—have shown that, in the Bessemer or Siemens-Martin metal, there is always, after the introduction of the spiegel, a small quantity of manganese, which sometimes amounts to half that introduced. Is it to be concluded, therefore, that the manganese remaining in the metal is beneficial—that it forms with the iron an alloy which improves the quality of the steel? Again, is it necessary, in order to introduce sufficient manganese into the metal, that an excess should be introduced? Recent experience has shown that manganese, without doubt, acts as a reducing agent in the oxide of iron. M. Bender, the engineer at Krupp's Steel Works, at Essen, has ascertained that 0.35 per cent of oxygen is sometimes found in Bessemer metal before the introduction of spiegel. It may be taken for granted that the addition of manganese imparts to steel new and useful properties, and when it was discovered that this manganese was the active element of spiegel, it is not surprising that experiments were soon undertaken with a view of condensing it in a special product. The result of the experiments which were practically conducted by Mr. Henderson, of Glasgow, was that ferro-manganese was introduced into the market. The yield of manganese did not exceed 25 per cent, and its characteristic feature was that it was not affected by the magnet. When, in England, the manufacture of the alloy was given up, the Terre Noire Steel-Works Company purchased the patent-right from the inventor, perfected the process, raised the yield of manganese to 75 per cent, and reduced the price 50 per cent.

Manufacture of Soft Steel.—Those manufacturers who are specially anxious about the quality of their produce have always used, in the final addition, in the Bessemer or Siemens-Martin process, 1 per cent of manganese, in the proportion of 10 per cent of spiegel to 10 per cent of manganese. The spiegel contained 5 per cent of carbon, and therefore the addition of 1 per cent of manganese always increased the carbon to 0.5 per cent, and it was difficult, if not impossible, to produce softer steel.

Mr. Henry Bessemer was the first to discover that, in introducing a small quantity of ferro-manganese, sufficient manganese for the reduction could be obtained, and the quantity of carbon would be considerably lessened also. As it is not necessary to melt the ferro-manganese, or to deal with the refuse that is occasioned by the smelting of spiegel, the quantity of manganese added might be less than 1 per cent if the yield of carbon were diminished, but it is found preferable to have 1 per cent as the standard. It has been shown that 1 per cent of manganese in the form of 10 per cent of spiegel, introduced 0.5 per cent of carbon into the metal; and 1 per cent of manganese in the form of 2 per cent of ferro-manganese at 50 per cent. will require no more than 0.1 per cent of carbon to be added. Experiments have shown that the richer the reducing alloy is in manganese the less carbon remains in the produce. Ferro-manganese containing 75 per cent of manganese is, therefore, the best where the softest metal is required.

The following is a comparative statement of the average resistance of steel manufactured from the same quality of pig-iron, but in the first instance spiegel was added, and in the second ferro-manganese:

	With Spiegel.	With Ferro-Manganese
Limit of elasticity.....	22 tons per sq. inch	16 tons per sq. inch
Breaking strain.....	33 " "	28 " "
Elongation per cent. measured over 8 inches.....	8 " "	25 " "

This decrease of the breaking strain, with the increased elongation, is a decided advantage where hardness of the material is not specially required. The metal which withstands a heavy breakage load with a small final elongation, has a special elasticity in the shape of resistance to change or form, which is apparent even when it is worked hot. In irregular pieces, this causes tensions, which often induce breakages when cooling, and it was to this unstable equilibrium of the molecule in hard steel that we must attribute, for the most part, the inapplicability of steel to any thing but rails and tires. It is necessary, when steel is to be used for plates, forgings, machinery, and such like purposes, that it should be very soft, and for these purposes consumers should not require it to stand a heavy breakage strain. In practice the loads are always supposed to fall with greater or less velocity, and are something similar to a shock. From the construction-point of view, the exact value of a material is the product obtained by multiplying the breakage strain by the final stretching, and not the breakage strains alone. These views were long since promulgated by Mr. Mallet, and are well known to English engineers. Applying them to the two kinds of steel named above, and also to common iron, we find: Hard, ordinary steel, 305; soft steel, 700; common iron, 105.

* Paper recently read before the Iron and Steel Institute, London.

Experiments made in France recently have shown that a cannon-ball projected against a wall, stayed by soft steel T-bars, caused only one-third of the damage that resulted when common T-iron stays were used. If hard steel had been employed, the result would not have been the same as when common iron was used. These experiments afforded proof of the superiority of soft material in resisting shocks. Moreover, the limit of the elasticity of soft steel as compared with that of iron—16 to 9—must be a sufficient guarantee against small imperfections in structure. It is even in the proportion of 9 to 16 that it is advisable in a general way to employ soft steel, when the diminution of dimensions which results therefrom does not cause practical difficulties. A saving in the weight of material, sometimes amounting to 40 per cent, will result, and, in most instances, this will mean decreased expenses, because the price of common iron and steel, in the future, will not show such a difference as they do now, steel in general being only 25 per cent dearer than iron. The superiority of soft steel is still more evident if we consider its use in comparison with that of the best classes of iron, such as those of Low Moor, Bowling, etc. At the Crewe Works, under the direction of Mr. Webb, the advantages of ferro-manganese have been made apparent in the manufacture of certain pieces of machinery which require great care in their production. The unlimited development of soft steel is only a question of time. The output is now equal to the demand, but as consumers increase their consumption of the material, the production must be increased also. Its use, in the future, will become a necessity as the substitution of steel for iron rails progresses. In France and in England, owing to the recommendation of Mr. Barnaby, soft-steel plates are used in a general way in the government shipbuilding yards, and the result is that the hulls weigh less, and more room is left for the cargo or the storage of coals.

The best way to adopt in employing ferro-manganese is to bring it to a red heat in order to facilitate the chemical reaction, and to avoid the scintillation which is produced when a cold body comes in contact with the liquid steel. This heating is readily done in the Siemens-Martin process by means of the furnace used for heating the materials of the charge. In the Bessemer process the ferro-manganese may be heated by placing it—as the weight is less, the alloy being richer—in an iron vessel suspended in front of the mouth of the converter. When the heating is completed the vessel is emptied into the converter, which is overturned at the same time. The reaction is perfect, and the running of the metal into the moulds mixes the two completely.

Comparing now the use of ferro-manganese with other methods which have been adopted to produce soft steel, it may be stated that the general idea was to restrict to the smallest possible limits the addition of spiegel, so as to lessen at the same time the proportion of carbon. This, however, produced a red-short steel which was scarcely fit for rolling. In carrying on the Bessemer process it is found impossible to go beyond a certain point in preventing an excess of iron oxide in the mass of molten metal. On adding the spiegel a violent reaction takes place between part of the carbon in the spiegel and the dissolved iron oxide. The result is an instantaneous production of carbonic oxide, which often forces part of the contents out of the converter. Of course, the metal is softer, but the process is uncertain, very costly, and dangerous to the men. Lastly, when the pig-iron intended for the Bessemer process contains 3 to 4 per cent of manganese, a steel fit for rolling is obtained without the final addition of spiegel, and therefore a soft steel is produced. The oxide of iron reacts upon all other oxidizable materials—first upon the silicon, then on the carbon, and lastly on the manganese. If, after the expulsion of the silicon and carbon, sufficient manganese is left to reduce to protoxide all the magnetic iron oxide which is produced, the metal is not red-short, as protoxide of iron and protoxide of manganese combine with the slag. Thus a malleable product, free from carbon, is obtained without the necessity of adding spiegel. This process, however, is both a difficult and uncertain one, for where it is adopted at all, it is necessary, in order not to spoil the manufacture, that the 3 to 4 per cent of manganese required shall exist naturally in the pig-iron. Where such pig-iron is used great skill is required on the part of the operator, as the spectroscope is not of any use, and the color of the slag is the only guide which can be followed. From time to time the "blow" is stopped, and by means of an iron bar samples of slag are taken out. When the quality of the product is found satisfactory the process is stopped, but it requires great skill to tell when this point has been reached. Generally the product is not regular, and owing to the high temperature employed it still retains, in spite of its little carbon, a particular crystalline structure, which is found also in Bessemer operations where the pig-iron is saturated with too much silicon. It is certain that in countries like Austria and the part of Germany where this process is used, soft metal, owing to the nature of the pig-iron, is not met with as a merchantable produce, and has not thus far produced good results. Ferro-manganese is there of great advantage, and to employ it usefully the manufacturers are doing all they can to lessen the yield of manganese in pig-iron. Ferro-manganese, therefore, is more generally being brought into use, as it is found to be the means of obtaining soft steel, and the reduction in the price is assisting in increasing its use, seeing that the employment is rendered more economical and judicious. Another advantage is that it can be applied as well to the Bessemer as to the Siemens-Martin process.

(To be continued.)

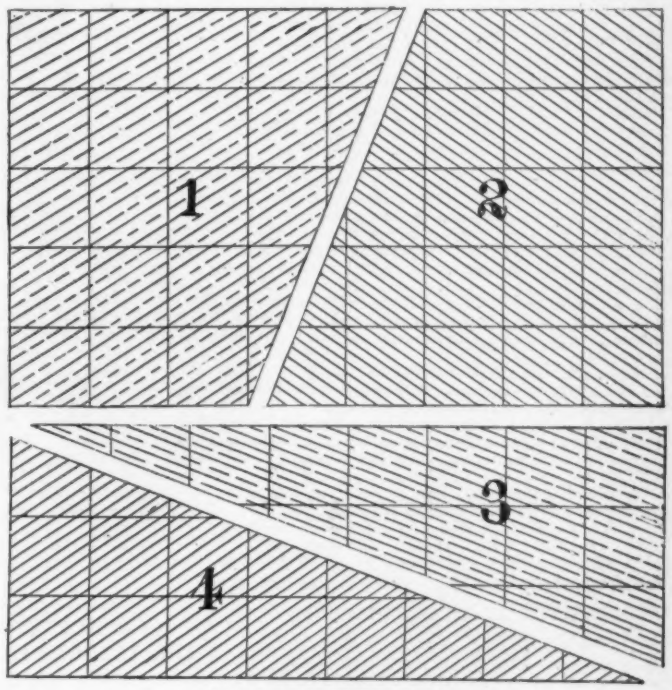
THE Dancing Flame, a curious apparatus, is thus described: "It consists of a small drum, with a very delicately sensitive elastic skin stretched over it. A stream of gas passed through this drum will burn as usual till some one begins to sing near it, when the flame, under the influence of the vibrating skin, commences to shake in a manner which is varied indefinitely, according to the notes of the tune."

THE SQUARE PUZZLE.

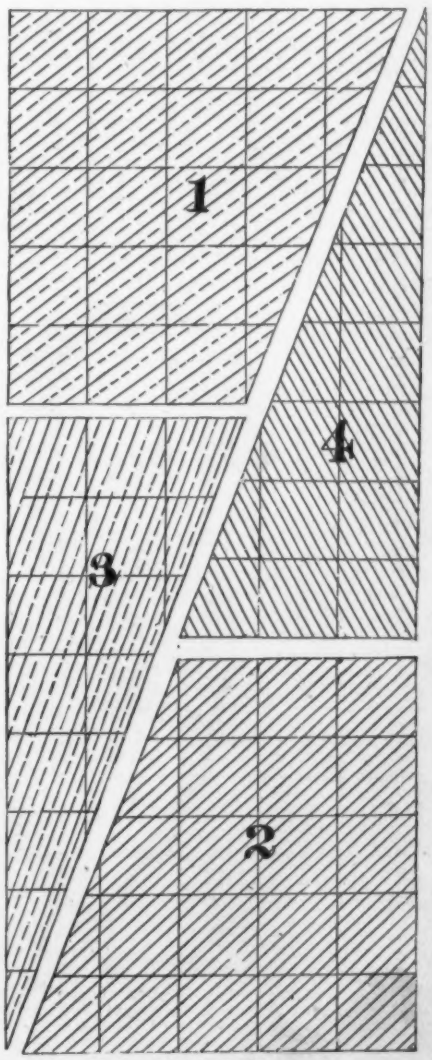
A CORRESPONDENT sends us the following puzzle, which we think is an apt illustration of the facility with which the human senses may be deceived. The best method of experiment is to line off a piece of stiff card-board as here indicated. Cut out the sections 1, 2, 3, 4, and then arrange them according to figures 1 and 2 respectively. Our correspondent says:

I'm not a fool, but I'm bothered. A friend gave me the enclosed pieces of paper, which are laid off in half-inch squares, and told me to arrange them as in Fig. 1, and count the squares. I did so, and reported 64, which was correct, the figure enclosing 16 square inches. Then he arranged them as in Fig. 2, and I counted again, and reported 65, which also was correct, as the papers in that form measured $2\frac{1}{2} \times 6\frac{1}{2} = 16\frac{1}{4}$ square inches $\times 4 = 65$. Where did the additional square come from? This may be an old puzzle, but I never saw it before, and would like to know the solution.

E. A. S.



THE SQUARE PUZZLE.—FIG. 1.



THE SQUARE PUZZLE.—FIG. 2.

This problem is seen to better advantage if the squares are made larger. Make them one-inch squares instead of half-inch.

THE CENTENNIAL COMMISSIONERS.

WE give the portraits of some of the leading members of the Centennial Commission, for which and the following particulars we are indebted to *Harper's Weekly*. The President, the Hon. Joseph R. Hawley, of Connecticut, has passed many years in public service. He was born in North Carolina in 1826, and was taken by his parents, at the age of eleven, to Connecticut, so that that State may fairly claim him as her own. As Governor, as member of Congress, as a soldier in the Union army, he has achieved an honorable reputation for ability, bravery, and administrative capacity. On the organization of the Centennial Commission, in 1871, he was elected its President. He has been re-elected to this position each succeeding year.

To Mr. John Welsh, President of the Centennial Board of Finance, is due much of the credit for the energetic manner in which the affairs of the Exhibition have been pushed forward. He is a native of Philadelphia, in which city he was born in 1805. A successful and honorable man of business, he has been for many years identified with the interests of Philadelphia, and enjoys the confidence and esteem of his fellow-citizens. For the past two years he has devoted his whole time to the affairs of the Exhibition.

The Hon. Daniel J. Morrell, Chairman of the Executive Committee of the Centennial Commission, is an eminent and successful manufacturer of Pennsylvania. He was born in Berwick, Maine, in 1821, on a farm on which his ancestors settled more than a century ago. His parents belonged to the Society of Friends, and he has always adhered to the religious training of his youth. In 1837 Mr. Morrell removed to Pennsylvania to better his fortunes, and by industry, energy, and upright dealings, rose from the position of a clerk in a mercantile house to one of independence and importance. Since 1855, Mr. Morrell has resided in Johnstown, Pennsylvania. He has been twice elected to Congress.

Alfred T. Goshorn, Director-General of the Exhibition, is a native of Cincinnati, Ohio, where he was born in 1834. He was admitted to the bar, after graduating at Hamilton College, but left his profession to engage in manufacturing, becoming the proprietor of extensive white-lead works in Cincinnati. In 1873 he was appointed to his present position on the Centennial Commission, and at once entered upon its responsible duties with great energy. All the details of the machinery of the Exhibition have been carried out under his admirable and sagacious supervision.

LOCOMOTIVES AT THE EXHIBITION.

ONE interesting class of exhibits will help to illustrate the early railway history of this country. In this department the Pennsylvania Railroad Company contribute the original locomotive "John Bull," of which the following interesting account is given in a printed hand-bill:

"The locomotive 'John Bull,' built by Messrs. George and Robert Stephenson, at Newcastle-upon-Tyne, England, for Camden and Amboy Railroad and Transportation Company, in the year 1831, arrived at Philadelphia, Pa., August, 1831; transferred to Bordentown, New-Jersey, September 4th, 1831. Original dimensions: Cylinders, 9 inches diameter, 2 inches stroke; one pair driving-wheels, 4 feet 6 inches diameter; one pair wheels, 4 feet 6 inches diameter, not connected; hubs of wheels of cast-iron; spokes and rim of wheels of wood, tires of wrought-iron; weight, about 10 tons.

"On arrival at Bordentown it was transferred from the sloop, on which it had been brought from Philadelphia, by means of wagons, to the only piece of permanent track of the Camden and Amboy Railroad Company then completed, about three-quarters of a mile in length, and about one mile distant from Bordentown. The machinery was there put together, and a tender constructed from a whiskey hogshead placed on a small four-wheeled platform car, which had been used by the contractor in the construction of the road. The connection between the pump of the locomotive and the tank was made by means of a leather hose fitted up by a shoemaker in Bordentown. The locomotive was first put in steam September 15th, and several trial trips were made before the first public trial on the 12th day of November, 1831—Isaac Dripps acting as engineman, Benjamin Higgins as fireman, and R. L. Stevens as general instructor and conductor.

A. T. GOSHORN, ESQ., DIRECTOR-GENERAL OF THE INTERNATIONAL EXHIBITION OF 1876.

The members of the New-Jersey legislature and a number of other prominent persons were among the guests present.

"The 'John Bull' remained at Bordentown until the year 1833, when the Camden and Amboy Railroad Company began running their cars by steam-power—the road having been previously operated with horses. It was then placed on the road, doing the regular routine service, and continued in successful operation until 1866."

Two cars, built about 1850 (the actual date not being known)—one a combined passenger-car, and the other a regular passenger-car—will be exhibited, coupled together with the engine "John Bull."

The Baltimore and Ohio Railroad Company send one of the early locomotives used on that road, an engine of the type then and since known as the "grasshopper" from its peculiar build. This description of locomotive solved the problem of running the sharp curves which characterized some American tracks in the early days of railway engineering in this country. The particular engine to be exhibited was built in 1835 by Phineas Davis, who was a Pennsylvania mechanic, and aided materially in the development of the American locomotive.

Among the contributions from the Baldwin Locomotive Works are engines made for the Pennsylvania Railroad Company after its standard, of the following classes and dimensions, namely: "C," Bituminous engine. Number of drivers, 4; diameter of drivers, 62 inches; diameter of boiler, 51 inches; size of cylinders, 17x24 inches; total wheel base of engine and tender, 44 ft. 5 in.; weight of engine in working order, 73,000 lbs.

Class "I" Engine.—Number of drivers, 8; diameter of drivers, 50 inches; diameter of boiler, 56½ inches; size of cylinders, 20x24 inches; total wheel-base of engine and tender, 47 feet 7 inches; total weight in running order, 92,000 lbs.

THE HORSE AND CARRIAGE HOTEL.

ONE of the wants that the Centennial Commission have for some time looked forward to with some anxiety—that is, how to provide for the vast number of horses and carriages which will congregate at the Exhibition—has at last been supplied by a party of enterprising gentlemen, who have leased the spacious plot of ground on the south side of Girard avenue, from Forty-first street to Belmont avenue, in close proximity to the Main Exhibition building, and have fitted up a grand pavilion, with accommodations for 3000 horses and carriages; and by direct telegraphic communication with the different buildings inside the Exhibition grounds and a system of checks, a visitor can at any moment order his horse or carriage to be brought to him, without the delay or difficulty that would otherwise attend the finding and ordering of them without such systematic arrangement.

THE TURBINE WATER-WHEELS AT THE EXHIBITION.

A MOST interesting feature of the Exhibition will be the show of turbines in operation. For this purpose a large water-tank, supported on six lofty iron columns, has been erected. From the tank a miniature Niagara River will descend and operate the wheels, and under the force of this artificial stream their respective capabilities will be tested. The water is returned to the tanks by steam-pumps.

BELGIAN MACHINERY AT THE EXHIBITION.

BELGIUM makes a fine display in the line of mechanics. Among her striking objects at the Exhibition is a mining apparatus of colossal dimensions for breaking rock and lifting up the fragments. The breaker looks like an exaggerated pile-driver, but is hollow, the interior being crossed with stout bars. The method of using this machine is to plump it down upon the refractory rock like a pile-driver, and then by an ingenious apparatus it is given a half twist. The fragments are brought up by an automatic grapnel. Next to this machine stands the engine used in the Belgian Mint—a Corliss engine. It was constructed at Ghent, and its finish is really beautiful, winning admiration from all machinists.

PROFESSOR ARCHER, of the British Commission, says that the parasite illustrated in a late issue of the SCIENTIFIC AMERICAN is, as we supposed, a specimen of the "dodder," and furthermore that the silk of the cybotum is used by the English government as lint for army purposes, having proved highly successful in that application.

JOHN WELSH, ESQ., PRESIDENT OF THE BOARD OF FINANCE.

HON. DANIEL J. MORRELL, CHAIRMAN OF THE EXECUTIVE COMMITTEE.

THE INTERNATIONAL EXHIBITION OF 1876.

THE EMPEROR OF BRAZIL AT THE EXHIBITION.

AMONG the distinguished foreign visitors to the great Exhibition now present is Dom Pedro II., Emperor of Brazil, who, with the Empress, has visited our shores as a private individual, having declined all official recognition.

Dom Pedro is well known as a lover of science, a man of far-reaching sagacity, unusual intelligence, and practical education. He is a man of great industry, and is making use of every moment of his time in this country in procuring information concerning our institutions and improvements. We present herewith his portrait.

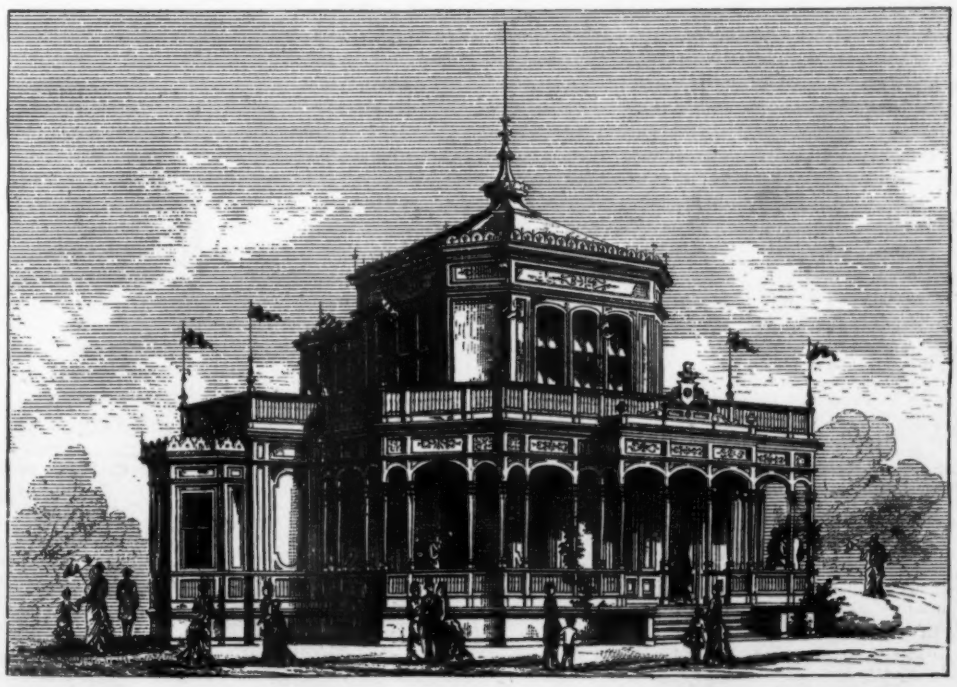
He was born in 1825, three years after the declaration of Brazil's independence of Portuguese rule under the leadership of Dom Pedro I., his father, and one year after the present constitution was adopted. When but six years old he was left by his father, who abdicated the throne of Brazil in 1831, and returning to Portugal to put himself at the head of the liberal movement there, never saw his boy again. The lad thus early orphaned for reasons of state, was committed to the care of José Bonifacio de Andrada e Silva, whose civic virtues and integrity have merited from his countrymen the title of the "George Washington of Brazil."

Under the fostering care of that great and good man, the lad grew and developed those tastes which honor his tutor and the land over which he has now reigned for a period of thirty-six years. The country showed its confidence in the young ruler and his training by declaring his majority at fourteen years of age. He visits us in his vigorous manhood, with a well-prepared mind and a keen observation. Nothing will escape him.

DOM PEDRO II., EMPEROR OF BRAZIL.

THE BRAZILIAN BUILDING.

OF the many special structures erected upon the Exhibition grounds, the Brazilian building is one of the finest in appearance. We give herewith a view, from the *Graphic*. The Brazilian exhibit is very extensive and interesting, comprising a large display of the native products for which that great country is so remarkable. The empire of Brazil is of immense extent, its area being 3,200,000 square miles, or about half a million square miles larger than the area of the United States.



THE INTERNATIONAL EXHIBITION OF 1876.—THE BRAZILIAN BUILDING.

THE GLACIARIUM.

ENGLISHMEN have evinced a warm interest in the healthful and enjoyable exercise of skating, although, owing to the variableness of the climate, it is only occasionally that they have the opportunity of indulging in the pastime. To make up for the deficiencies of nature, it has more than once been proposed to call in the aid of art to produce a sufficient surface of ice by artificial refrigeration, and so to render skating on real ice independent of the seasons; in fact, to enable it to be practised all the year round. Until now this has, so far as we are aware, never been accomplished, although about two years since a compromise was effected by the introduction of wheel-skating on asphalt or cement rinks. A real ice-rink, however, has now been made a possibility by Mr. John Gamgee, who has for some years past given his attention to the economical production of artificial cold. He has, he informs us, succeeded in freezing a body of water and maintaining it in the condition of ice at so low a cost as to render a real ice-rink no longer prohibitory on the score of expense. This ice-rink, which is the first of its kind, is situated at an establishment which is designated the Glaciarium, and which is situated at No. 379 King's road, Chelsea, and to which we recently paid a visit.

Before describing the arrangements of the Glaciarium, it may be interesting to notice the various propositions which have been made from time to time for producing skating-surfaces of real ice, none of which, however, we believe, were ever carried into effect, although about thirty years since a skating-hall was opened in Grafton street, Tottenham-court road, the material used being a mixture of alum and hydrochloric acid, upon which ordinary skates were used. The first proposition appears to have emanated from Mr. A. W. Parker, of Bow, who in 1865 proposed to place a coil or series of refrigerating pipes in a shallow trough of water, and by freezing the water to form a skating-rink. The next proposition is of a more definite nature, and was advanced by Mr. H. P. Gengembre, of Pittsburg, Pa., in 1866. In this case the floor was to be formed of a series of boxes communicating with each other and with a refrigerating-machine. The floor was, in fact, a shallow trough filled with water which was to be converted into ice and maintained in a suitable condition for skating. In 1870 Mr. M. J. Bujac, of New-York, patented an arrangement for producing ice for skating on. He proposed a shallow trough for the water, in which pipes were to be laid through which gases or other freezing-agents were to be conducted. His definite proposition was to have a circular skating-floor, the ice being produced and maintained in proper condition by several of Carré's freezing-machines. In March, 1875, Messrs. F. N. Mackay and D. Rae obtained a patent for ice skating-rinks which were to be constructed by having a floor of iron plates carried on iron girders, the spaces between the plates, the girders, and their bed forming the conduits for the brine, or refrigerating medium. The spaces, however, being of large area, diaphragms or deflectors were introduced to give the brine a zigzag course. In June, 1875, Messrs. H. J. West and G. Du Vallon took out a patent for a similar object, which was effected in a similar manner. The rink was to be constructed with a shallow metallic trough for the water, supported on transverse iron girders which rested on a concrete floor. The spaces between the girders and the floors were to be connected at the ends, and charged with brine or other uncongealable liquid in connection with refrigerators operated by the evaporation of ether. The circulation of the brine was to be effected by pumping. In both these latter instances it will be seen that the proposition was to apply the cooling medium beneath the floors instead of through the tubes placed in the body of the water itself.

In designing the skating-rink at Chelsea, Mr. Gamgee originally proposed to have a floor of iron plates carried on transverse girders of the same metal, which were laid on wood bedded on concrete, the refrigerating liquid flowing through the spaces thus formed. This was in 1874, but in practice Mr. Gamgee considerably modified this notion of laying a series of cast-iron pipes of rectangular section connected on a bed of concrete, and grouting them with cement. In the case of the Glaciarium the concrete bed is 24 feet long by 16 feet wide, giving only a comparatively small rink of about 43 square yards area; but then it is an experimental rink. Around the concrete is a raised ledge forming a trough containing water to be congealed, which is about 2 inches deep, and which surrounds three sides of each of the pipes. In selecting the liquid for producing congelation, Mr. Gamgee discarded the use of brine for the reason that saline solutions act destructively on metallic surfaces from galvanic and chemical causes. Besides, such media are themselves liable to congelation if exposed to too low a temperature, or if the circulation be sluggish, so that a fatal obstruction might be caused. He therefore uses as a cold transmitting liquid a mixture of glycerine and water, which remains uncongealed at a temperature below zero. This liquid is pumped up at starting from the refrigerator into a tank, the bottom of which is about 10 feet above the level of the machinery-house in which it is placed, and where it is kept at the required temperature. From the tank the liquid flows by gravitation through about 55 feet of pipe to the rink, and having passed through the tubes imbedded in the ice, returns by gravitation to the refrigerator to be pumped gently up again into the tank. Before, however, the solution enters the main refrigerator it passes through a worm in an auxiliary refrigerator, which is supplied with ice-dust produced by the skaters on the rink, the dust being mixed with salt.

The freezing-apparatus is an ether machine, the ether being exhausted from the refrigerator and forced into the condenser by an air-pump driven by a steam-engine. About four gallons of ether is the quantity stated by Mr. Gamgee to be in use, while he affirms that it requires but very infrequent renewal, and then only in very small quantities. The refrigerator is a copper box about 5 feet square, fitted with a series of vertical tubes, and placed in a wooden tank. The glycerine mixture surrounds the copper box and passes through the tubes, the ether of course being inside. The condenser is about the same size as the refrigerator, and is similarly constructed, except that the tubes are placed horizontally, and are double. The condensing water circulates through the inner tubes and outside the outer tubes, while the ether passes through the annular space between the two tubes, returning thence to the refrigerator. It will thus be seen that there are two circulating systems maintained, that of the glycerine solution and that of the ether, both of which have worked uninterruptedly since the ice was first formed and the rink opened, which was on the 7th of January last.

The rink is not a public one, but is open to private subscribers, who enter upon certain conditions. A number of noblemen and gentlemen have tested its skating qualities for the past two months, and many of these have signed a document testifying to its complete success, the Marquis of Clanricarde heading the signatures. Up to the present time there has not been any breakdown, and the worst delay that could arise would probably be caused by the failure of the pump-valves. These could be replaced in a few hours without fear of reducing the temperature of the glycerine solution, there being a large quantity of it. In fact, Mr. Gamgee states that he could hold out for 48 hours, during which time the solution could be kept slowly circulating without its efficiency becoming seriously impaired. The slight wear on the surface of the ice produced by the skaters is repaired each evening by sprinkling the rink with water from a water-pot. The rink is enclosed in a canvas building, and a temperature of over 60° Fahr. has been at times reached in it without detriment to the ice. The only drawback experienced has been from a saturated atmosphere with low barometric pressure, which causes an aqueous deposit on the surface of the ice which solidifies rather roughly. In other respects there is no drawback to the skater's enjoyment, except, perhaps, limited space. As to the question whether the rink can be made to pay, Mr. Gamgee states that the charges for labor and coals, which are the chief items of cost, only amount to £12 per week, and that that would not be increased with a very much larger rink. No thorough trial of the arrangement by independent engineers has, however, so far as we are aware, yet been made.

We have said that the present rink is only experimental, but we must add that a larger one is in course of construction, and is, in fact, nearly completed. This rink is inclosed in a permanent building fitted with galleries for spectators. The skating-surface will measure 40 feet by 24 feet, thus inclosing about 107 square yards. The rink is formed with a concrete foundation 6 inches thick, upon which is laid a bed of loose, dry earth 4 inches thick. Upon this again is a 6-inch layer of cow-hair carrying a layer of 2-inch deal-planks, forming a level floor with raised edges and being covered with ¼ inch of tarred cowhair. On this are laid the pipes which, instead of being rectangular and of iron, are of copper, of a flat-oval section, 2½ inches wide by ¾ inch deep, No. 16 gauge, and connected at the ends. By substituting copper for iron, and thus altering the sectional form, all chance of accident from unequal expansion is avoided. The ice will be about the same thickness as in the present rink—that is, 2 inches. Mr. Gamgee contemplates introducing several improvements in the details of the mechanical arrangement of the new rink which we hope to place before our readers. In the mean time, we can but congratulate Mr. Gamgee on having enabled skaters to enjoy their pastime on real ice at all seasons of the year.—*Engineering*.

THE composition invented by Mr. G. F. Heyl, of Charlottenburg, consists of palm-oil or oil of Senegal, about 20 parts; coloring matter (hydrated protoxide of iron or chromate of gead and Prussian blue), 100 parts; varnish, 20; lac, in scale, or flakes, 10; pyroligneous spirit or alcohol, 120; resinous gum or euphorbia, 50; chloride of mercury, 15; and arsenic, 05=350 parts.

[Journal of the Franklin Institute.]

ELECTRICAL PHENOMENA.

THE ALLEGED ETHERIC FORCE—TEST EXPERIMENTS AS TO ITS IDENTITY WITH INDUCED ELECTRICITY.

By PROF. E. J. HOUSTON and PROF. ELIHU THOMSON.

SINCE the experiments of Mr. Edison are still believed by some to demonstrate the existence of a force hitherto unknown, we submit the following considerations, together with experiments which we believe to be crucial in establishing the identity of the supposed new force with inverse currents of induced electricity. The alleged necessity for the assumption of the new force being based on its asserted lack of polarity, we propose to show how two opposite phases of the so-called new force may neutralize each other, thus conclusively establishing its polarity.

In order to show that, in Mr. Edison's experiments, inverse electrical currents must necessarily exist, notwithstanding the fact that the manifestations occur only at the *opening* or breaking of the circuit, we will discuss his typical experiment in detail. In Fig. 1 we have the well-known arrangement for the production of the alleged new force. On the completion of the circuit, the battery current flows as shown by the arrows, and M becomes a magnet. On breaking the connection as at K, the so-called etheric force is manifested at the points P in the dark box. It is evident that the above embraces all the essentials of Mr. Edison's experiments.

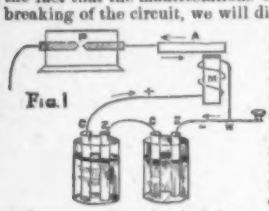


FIG. 1

When a battery current flowing through a considerable length of wire is interrupted by breaking contact as at K, a bright spark of appreciable length is seen at the break (K). This spark is due to the extra current, and indicates a great increase of electrical tension in the wire, the discharge occurring through an appreciable air-space at K. It will be seen that the wire around the magnet is at the moment of breaking contact charged with electricity of considerable tension (extra current), positive or negative according to the direction of the battery current. In Fig. 1, since the magnet wire is connected with the positive pole C of the battery, the charge in the wire will be positive, and a negative charge will be accumulated on the general conducting surface of the battery, which thus acts in part to condense the negative charge. This state of tension at once disappears on the discharge of the extra current. The extra current is not produced until the circuit is broken, and its discharge takes place when the wires have been appreciably separated, as shown by the spark. At every break, therefore, the wire surrounding the core of the magnet accumulates a static charge of considerable tension, which is rapidly discharged. This charge, acting by induction on the core of the magnet, induces in it, and in all metallic masses in connection therewith, a flow or charge in one direction, *while the tension in the wire is increasing*, followed instantaneously by a flow or charge in the reverse direction for the re-establishment of electrical equilibrium in the cores of the magnet, *consequent on the discharge of the wire itself*, the wire and the cores of the magnets bearing the same relations to each other as the inner and the outer coatings of a Leyden jar. Here, then, we have all that is necessary for the production of the so-called etheric effects, apparent non-polarity included.

In order to prevent the possibility of a charge of any tension remaining in the coils of wire on the interruption of the current, we arranged the following experiment: A battery of eight cells was divided into two sets of four cells each, as shown in Fig 2. The sounder magnet M, used in this experiment, was connected as shown—that is, one end of the coils with the positive pole of the left-hand battery, and the other end to the negative pole of the right-hand one. An interrupter placed midway between the remaining poles of each battery furnished the necessary breaks, as at K. Under these conditions we could obtain no appreciable spark in the dark box at P. In this experiment the magnet is placed so as to occupy the exact middle of the circuit, one half the wire in the coils being influenced by that part of the extra current which produces a positive charge, and the other half by that which produces a negative one. When thus arranged, the inductive effects of the extra current, being equal and opposite, neutralize each other, and hence no inductive spark appears in the dark box P. In this experiment thorough insulation of the batteries, key, and connecting wires is necessary, in order to secure an equal division of the effective circuit.

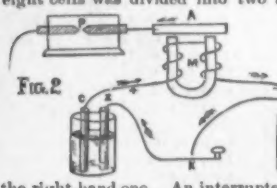


FIG. 2

The absolute necessity for the equality of the two divisions of the circuit and of the neighboring conducting-surfaces, in the above experiment, is shown by connecting any part of the circuit with a conducting-surface, as, for instance, a mass of metal, or even the body of the experimenter, when sparks at once make their appearance at P. The mere approach of the person, *without* contact with any conducting-surface near to any part of the circuit, or to either of the batteries, is followed by a similar result. In this connection it is evident that any inequality in the metallic surroundings of the halves of the circuit is sufficient to cause irregularity in the results. So necessary is the *equal* division of the conducting-surfaces that even the use of an ordinary telegraphic key at K is sufficient to introduce unequal metallic surfaces into the circuit, and so derange the experiment; and we would therefore suggest that the breaks be made by the conducting-wires themselves. If the battery be unequally divided, sparks are seen in abundance in the dark box.

To test the question of the polarity of the alleged new force, the following experiment was devised: The battery terminals were connected respectively with one end of the coils of the magnets M and M', which were exact counterparts of each other. The circuit was completed through the interrupter K, connected with the two remaining ends of the coils. Wires *a* and *a'* were provided for connecting the cores of the magnets with the dark box P at pleasure. When wire *a* was connected with P, sparks were seen in the dark box in breaking the contact at K, similar sparks were seen where the wire from *a'* was alone connected. When *both a* and *a'* were connected with the dark box, *no spark could be obtained.*

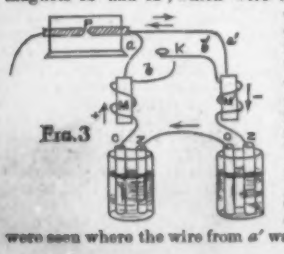


FIG. 3

In the foregoing experiment it is evident that the polarity of the extra current produced in M is the opposite of that in M', representing, as they do, the positive and negative poles continued from the battery. Under these circumstances the induced charges in each core, being opposite, neutralize each other, and no spark is seen. Since, however, contact of *a* or *a'* with M or M' singly gave all the so-called etheric manifestations, and that when both were connected no spark was obtained, *it is clear that in this experiment is presented unquestioned evidence of that polarity which has apparently been wanting, and which want has thus far furnished the only grounds for the assumption of the discovery of a new force.*

That the non-appearance of the spark at P was due to an exact neutralization of the two opposite phases of the "etheric force," is shown by bringing any conducting-surface, as the finger, into contact with any part of the circuit, as at *b* and *b'*, when sparks at once appeared at P.

We found that it was not necessary to employ cores surrounded by coils of wire to produce the so-called etheric force. We note the following experiment: A hollow cylinder of non-conducting material as a test tube was covered on the outside with a sheet of metal. A metallic bar was placed inside the tube, and from it a wire was led to the dark box. On connecting the exterior metal surface with almost any portion of a long battery-circuit, which was interrupted, sparks were seen in the dark box at every break. These sparks possess all the properties claimed for the "etheric" sparks. In this case no person at all familiar with electrical induction would for a moment question the true origin of the sparks seen in the dark box.

Metallic coatings are not necessary to produce the effects just described. In the following experiment we replaced them by liquid surfaces: In a tumbler partly filled with slightly acidulated water, a test tube is placed, also filled with acidulated water. The wire W, connected with the battery wire B, interrupted at K, is inserted in the test tube. The wire S, in connection with the dark box, dips into the liquid in the tumbler. On interruption of the circuit, sparks appear at the dark box P. Comment is unnecessary.

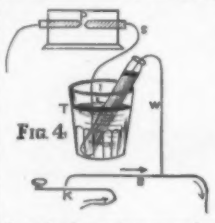
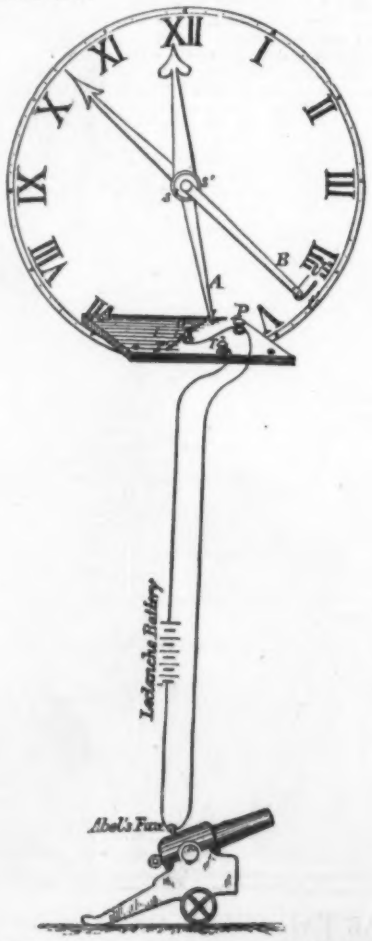


FIG. 4

It may be interesting to state that the foregoing experiments were thought out in accordance with the known laws of electricity, and the results fully confirmed our expectations. It is hoped that the foregoing experiments will have established still more decidedly the fact that *all the manifestations classed as "etheric" are due solely to inverse currents of induced electricity.*

THE ELECTRICAL TIME GUN AT PERNAMBUCO.

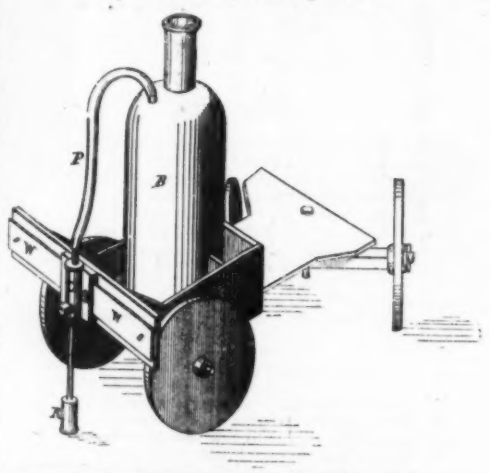
THE following description of the manner in which the time gun is fired at Pernambuco is given by Mr. Andrew Jamieson, assistant engineer and electrician on the Western and Brazilian Line:



In the above sketch the large circle is to indicate the dial face of the large clock fixed in the tower of the Arsenal de Marinha, Pernambuco, which, you may remember, is some 400 yards from the S. and B. Telegraph Office. S is the hollow spindle of the hour hand, S_1 the spindle for the minute hand. To these spindles I firmly fixed, at about four feet from the face, or inside end of hour hand spindle, two large levers, A and B, two feet in length, and diametrically opposite to the clock handles (inside the tower). To the end of lever B was attached two platinum-pointed springs, the points of both levers A and B being well *insulated* from their attachment to the minute hand spindles by the intervention of suitably arranged pieces of ebonite. Immediately underneath the plane of motion of these levers (A and B) was fixed on a neat mahogany stand an ebonite slab (I) of some 10 in. by 6 in. by $\frac{1}{4}$th in., at the centre of which was screwed a terminal O, with a lever L radiating upon O in a horizontal plane, but unless acted upon was kept in an angular position, by a light spring, across the length of the ebonite slab. This spring and lever L were so adjusted that when the hour hand came to ten minutes to twelve, noon, the end of lever A fixed to same spindle (as the time drew nearer and nearer to twelve) made contact and gradually brought L to a position at right angles to the length of the ebonite slab, whereby the other end T, of L, was now in a position to make contact with the more quickly passing lever B at its platinum point t_1, and at the same moment (the sixth stroke of the clock) spring t_2 comes in contact with a spring attached to terminal T_2, which is in electrical connection with one pole of a 30-cell Leclanché battery, the other pole communicating by means of an underground cable, with one side of an Abel's patent fuse inserted in the touch-hole of the cannon, while the other side of fuse is returned to the central terminal (O) of lever L by another cable attached to P, and from thence by wire to O, so that when t_1 touches T_1, and t_2 T_2, the circuit is completed, the fuse exploded, and the gun fired. The levers A and B move on, L falls back to its angular position under action of the aforementioned spring, and is only affected by A and B twelve hours afterwards, but as the ends of the cable are freed by the explosion, and the gun only loaded once in the twenty-four hours—namely, at 11 A.M.—the electrical current flows but once in the twenty-four hours.

NEW STEAM PAVEMENT-RAMMER.

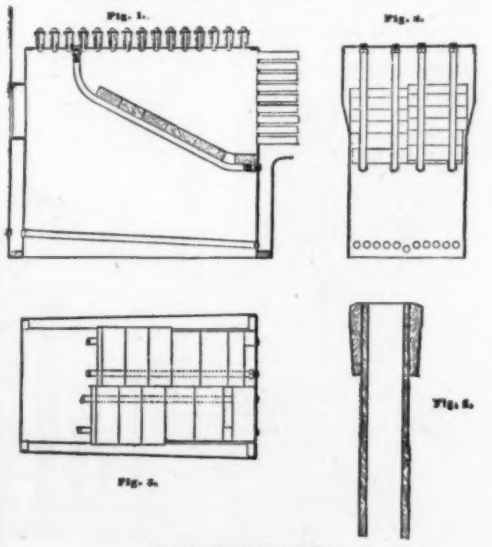
By S. JOHNSON, Philadelphia, Pa.



A BOILER, B, is mounted on a carriage of any suitable construction; P, a flexible steam-pipe, conveying steam to the steam-cylinder C, which operates the rammer R in the ordinary manner in which a steam-hammer is driven and controlled. The cylinder is attached to a slide, S, which traverses across from side to side on a guide or way, W, placed at the rear of the machine, in a line parallel to the rear axle-tree. The slide is moved at the pleasure of the workman.

LOCOMOTIVE FIRE-BOX, PENNSYLVANIA R.R.

OUR engravings represent a method of constructing the fire-brick arches used in locomotive fire-boxes, which, although extensively used in the passenger-engines on the Pennsylvania Railroad, is not very generally known elsewhere. Fig. 1 represents a longitudinal section of the fire-box, Fig. 2 a transverse section, Fig. 3, a plan, and Fig. 4, an enlarged view of the thimble on the end of the tubes, by which they are fastened into the fire-box plates.



LOCOMOTIVE FIRE-BOX.

It will be seen from the engravings that the peculiarity of this fire-box consists in the manner in which the fire-bricks are supported. These rest on tubes which are fastened into the tube plate below the fire-tubes, and extend backward and upward, and at the other end are fastened into the crown sheet. The tubes are screwed into a brass thimble, the outside of which has a tapered screw. This thimble is then screwed into a corresponding hole in the tube or crown plate, and, being tapered, can be screwed up until it is tight. From the engraving it will be seen that four such tubes are used, and that the fire-brick rests on these tubes. The heat to which they are exposed produces a violent circulation through them and thus protects them from the action of the fire. This plan has been used for a number of years on the Pennsylvania Railroad, and

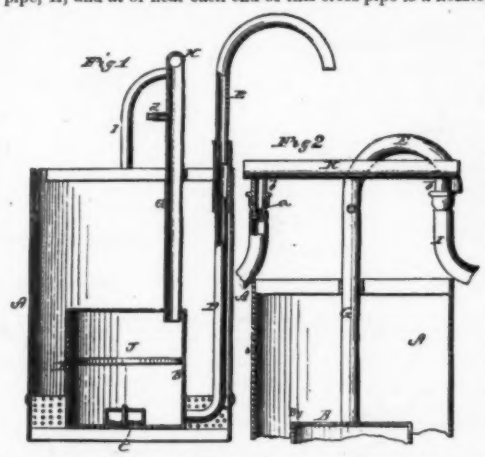
with great success. Probably with this arrangement and a deflecter over the fire-hole, as good results in the combustion of coal can be obtained as with any means now in use. We are inclined to believe, however, that if, instead of leaving the opening for the flame above the fire-brick the whole width of the fire-box, it was contracted to about the size of the fire-hole, better results could be obtained. A water grate is used with this system, and, we believe, on all the engines on that line.—*Railroad Gazette.*

SUPPLYING LOCOMOTIVES WITH WATER.

By HENRY HOWE, Council Bluffs, Iowa.

A TANK submerged in a well, is provided with suitable pipes, so arranged that the steam from the locomotive may be admitted into the tank, thus forcing the water up into the tender.

Within the well, A, immersed in the water, is a tank, B, with valve, C, in the bottom. From near the bottom of this tank a pipe, D, extends above the ground, and has a swiveled spout, E, through which the water is forced out into the tender; this swiveled spout can be turned out of the way of the track after using. From the top of the tank, B, extends a pipe, G, above ground, at the top of which pipe is a cross-pipe, H, and at or near each end of this cross-pipe is a nozzle,

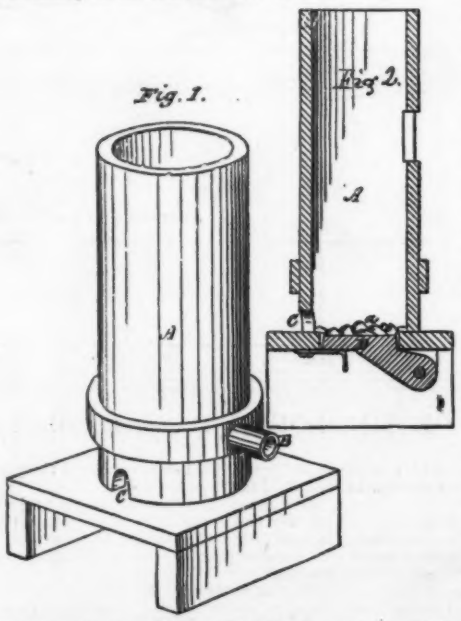


b, to which a flexible pipe, I, is attached. In each nozzle or connection *b* is a check-valve, *a*, of any suitable construction. Either of the flexible pipes I is to be connected with the boiler of the locomotive, so as to allow steam to enter the tank to force the water down and out through the pipe D. The check-valves *a* operate so that when steam is passing through one of the flexible pipes it lifts the valve on that side and closes the one at the other end. By means of these valves, also, when the pipes I are disconnected from the boiler, the steam in the tank can not escape, but must condense and form a vacuum, and cause the water to rush in and fill the tank. By having a flexible connecting-pipe at each end of the cross-pipe H, one of said pipes I will always be at the proper place for the engine in going either way. In the pipe G is a small stop-cock, *d*, to let the air pass out of the tank at the first filling, after which it will not be needed, as no more air can get in. In the tank B is used a float, J, in order that the steam may not come in immediate contact with the water.

NEW PROCESS FOR IRON.

By WILLIAM BATTY, Philadelphia, Pa.

THE object is to facilitate the operation of melting cast-iron in a cupola or blast-furnace, and at the same time carbonizing instead of decarbonizing the "charge" of metal—the latter being the result of the usual process of melting—and also to get the highest degree of heat with the least quantity of air necessary for the combustion of the fuel.



A represents an ordinary cupola-furnace; B, tuyere-hole; C, gate or draw-off; D, hinged door at the bottom of the furnace.

In preparing the furnace for the melting-process, after closing and fastening the door D, I form a bed of charcoal below the tuyere hole B, and place the kindling thereon. I then charge the furnace in the usual manner. With the blast through the tuyere or tuyeres, I blow in the gas-carbon, or the coal-oil carbon, or both, in a finely-pulverized state—they being fed into the blast-pipe by any suitable device—the slag that forms in the furnace lying between the tuyeres and the top of the charcoal-bed, which prevents the latter burning out, while the molten iron circulates through the charcoal and takes up such quantity of carbon as will refine, purify, and soften the cast-iron.

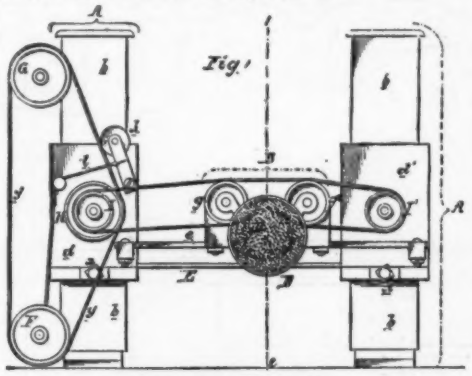
The object of blowing in the carbon is to take up the excess of oxygen in the air, the oxygen having a greater affinity for the carbon than for the iron. By this process I am enabled to get the requisite amount of heat with a less amount of air than can be obtained in any other way.

APPARATUS FOR CLEANING BRICK WALLS.

By J. WATERMAN, Philadelphia, Pa.

THE means which I prefer of applying power to the cleaning-brush D are shown more fully in Fig. 1, in which F represents a pulley secured to a driving-shaft, which turns in bearings on the lowermost section of one of the end-frames A, a similar pulley, G, being secured to a shaft carried by the uppermost section of said frame, and the driving-belt *y* passing round both these pulleys and round a pulley, H, the shaft of which turns in bearings in the end-piece *d*, and carries at its outer end a smaller pulley, I. The opposite end-piece *d'* also carries a pulley, I', similar to the pulley I, and a belt passes round the pulleys I and I', and over and between the pulleys *g*, *g*¹, and *g*², carried by the sliding carriage B, the pulley *g* communicating motion to the spindle of the brush D.

A hinged arm, *j*, is secured to the end-piece *d*, and carries at its outer end a roller, *k*, which can be moved inward against the belt *y*, by drawing upon the cord or chain *l*, so as to increase or diminish the tension upon said belt.



The spindle *f* has at its inner end a knob, *h*, by pressing upon which the attendant, standing upon the platform E, can force the cleaning-brush D against the surface of the wall to be operated upon, a spiral-spring, *i*, tending to remove the brush from contact with the wall, when pressure is removed from the knob.

The end-pieces *d d'* of the brush-carrying frame have jaws at each end, which embrace the edges of the guiding-plates *b*, so that the said frame can be adjusted vertically to any desired position, set-screws *x* serving to secure the same in place after adjustment.

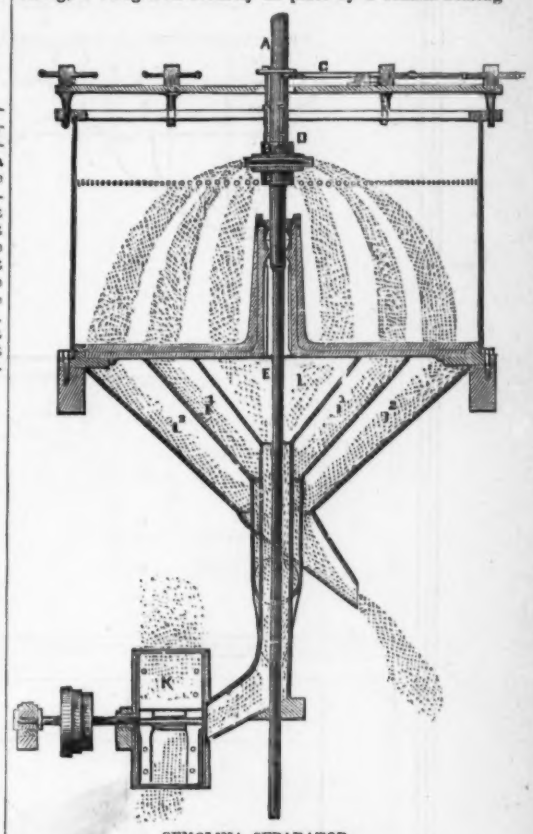
The revolving-brush D consists, preferably, of a disk, in which are inserted a number of short pieces of wire; but any device which will have a scraping or scratching effect on the surface of the brick or stone may be employed, or a bristle-brush and water may be used when a painted wall is to be operated upon.

The above-described apparatus can be made of any desired width or height, and is intended to be erected in proximity to the wall of a building to be cleaned, in the same manner as a painter's scaffold, every part of the wall being rapidly and effectively operated upon by the brush D, owing to the ready adjustability of the latter.

SEMOLINA.

MR. BUCHHOLZ, in his specification for an "Improved apparatus for manufacturing and assorting semolina, and reducing same to flour," describes the following curious machine for separating bran from semolina, and at the same time separating the light from the heavy particles of semolina by means of centrifugal plates, etc.:

"In order to assort the grains of semolina according to their qualities, and remove the bran therefrom, I use a novel kind of centrifugal machine (see sketch), which is shown in sectional elevation. This may be described as follows: A hopper (not shown in the drawing) is provided for receiving the material to be assorted. The pendant discharge-tube (A) of this hopper is fitted at bottom with a valve (B), which represents what I term the spreader, to be more particularly referred to hereafter. The valve (B) is capable of vertical adjustment by means of a balanced rock-lever (C), to regulate the flow of the material from the hopper into the assorting machine. The semolina, with the bran, falls from this hopper into the spreader before-mentioned, which consists of a rotating chamber, in the periphery of which are openings to allow of the discharge of the material horizontally, and its consequent descent nearer to or farther from the axis of rotation of the spreader, according to the specific gravity of the individual particles. The rotating chamber admits of some modification in its construction, as will be hereafter noticed. It is composed of two main parts (D, D'); an open cylinder of wood (D) with a flange at bottom is set over a flanged boss (D'), also of wood, keyed to a vertical spindle (E). The two flanged pieces are so connected together as to leave an annular lateral opening between them for the discharge of the semolina. This connection is effected by means of steel blades inserted in vertical grooves cut radially, and at equal distances apart in the flanges. These blades, which serve as division-plates for the annular space, are secured to the parts (D, D') by means of rings, which enter cross-notches cut in the blades, and ring-grooves formed in the periphery of the flanges. The apparatus thus constructed is mounted in a cylindrical casing, and the spindle (E) projects down through the bottom of the casing, it being held securely in place by a central-bearing



SEMOLINA SEPARATOR.

cast on the bottom of the casing. The shaft may be driven by gearing in the ordinary way. Below the casing, and connected by means of openings in the bottom with the interior, is a set of three, or it may be less or more, concentric funnels (I, I¹, I²), which are intended respectively to receive the assorted substances, and deliver them to proper receptacles. By the rotation of the spreader, into which the semolina to be assorted is delivered, a centrifugal motion will be imparted to the semolina, and the heavy grains discharged into the casing will fall near its periphery, and find their way into the outer funnel (I²); the lighter semolina will fall within the circle of the heavier particles, and will be discharged into the second funnel (I¹), and the bran mixed with the semolina will fall nearer the centre of motion, and escape through the central funnel (I). To facilitate the operation of this apparatus, I propose to admit air freely to the cylindrical case, and to maintain a partial exhaustion in the funnels by means of an exhaust-fan (K), which I connect thereto. The semolina thus assorted I propose to reduce to flour, using the heavy or best semolina for the best flour, and the lighter for an inferior quality."

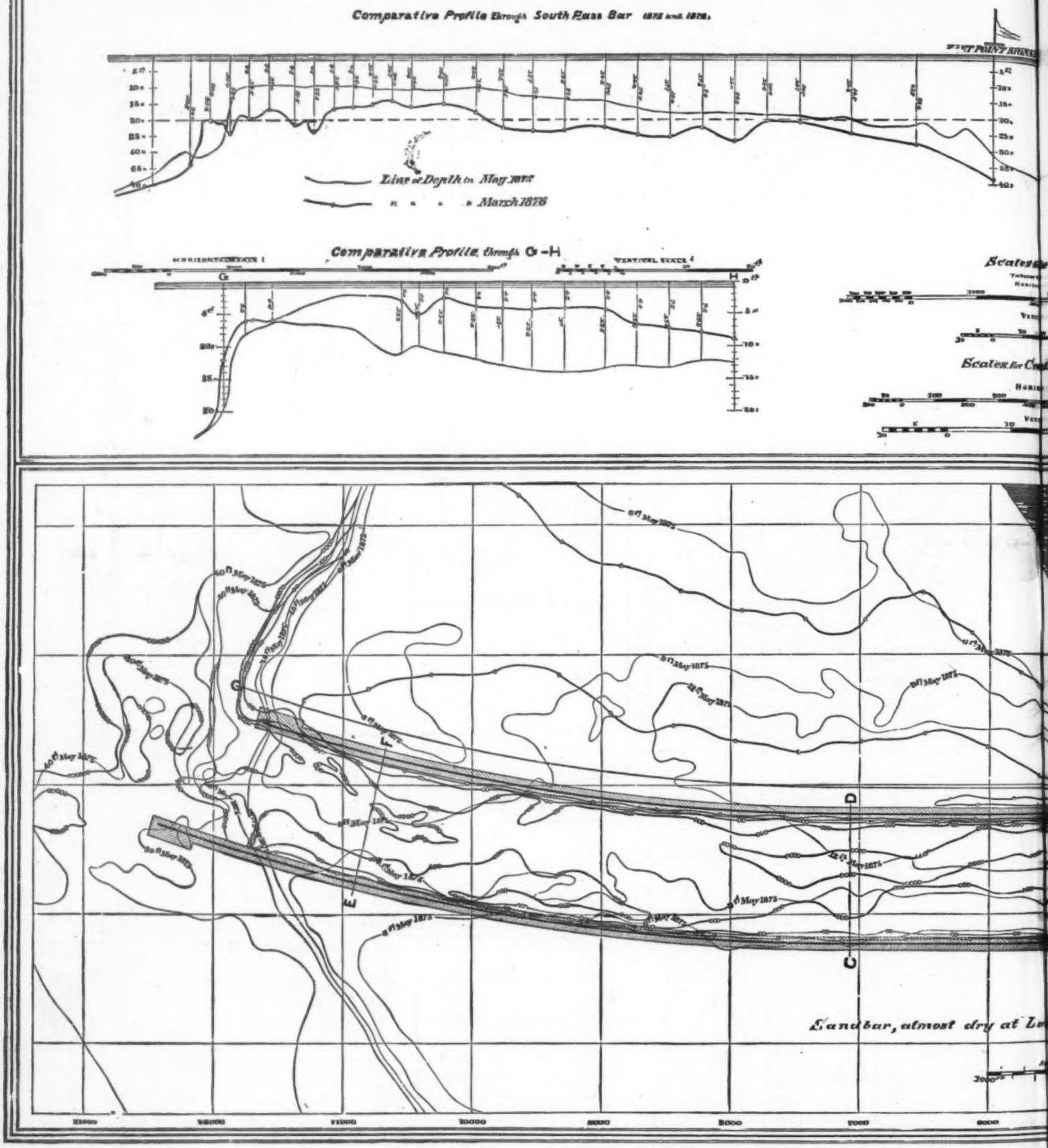
NEW UMBRELLA-SUPPORTER.

By E. M. ARNOLD, Houston, Texas.

A DEVICE for supporting and carrying a parasol or umbrella in such a way as to leave the hands free. The parasol may also be tilted forward or back, or to either side.

A are two rods, curved to fit upon the forward side of and pass over the shoulders of the wearer. The lower ends of

the rods A are attached or hinged to ring B, clasped around the waist. The upper parts of the rods A have a coil formed in them to give them elasticity, are bent upward, and coiled to form a socket to receive the handle of the parasol or umbrella. To the rods A are attached straps C, passed around the arms or across the breast of the wearer, to keep the said rods in place. D are elastic straps, which are attached to the frame of the parasol or umbrella, and the free ends of which are provided with loops or rings to catch upon buttons a^2, attached to the belt E, so that by adjusting the straps D the parasol or umbrella may be tilted or inclined forward or backward, or to either side, as circumstances may require.


Comparative Profile through South Pass Bar 1872 and 1876.
Line of Depth in May 1875
" " " March 1876
Comparative Profile through G-H
Scales
Scales for Cuttings
Sandbar, almost dry at Low
CHART OF THE SOUTH PASS, MISSISSIPPI RIVER,

THE SOUTH PASS (MISSISSIPPI RIVER) JETTY-WORKS.

By E. L. CORTELL, C.E., Chief Assistant Engineer of the Works.

So much has been written on the subject of jetties at the mouth of the Mississippi River; so many arguments, *pro* and *contra* have appeared in the public press, in engineering papers, in official reports, and in descriptive and illustrative pamphlets; so many distinguished and experienced engineers have so fully treated the subject, that but little that is new can be said.

Your own valued paper even has given so complete a description of the jetty-works that it seems proper to give only a few details perhaps before unmentioned, and to explain the map and profiles, prepared from recent examinations, which accompany this paper, to show, by a comparison of actual data of different dates, the progress made in one year since the passage of the act authorizing the construction of the jetties.

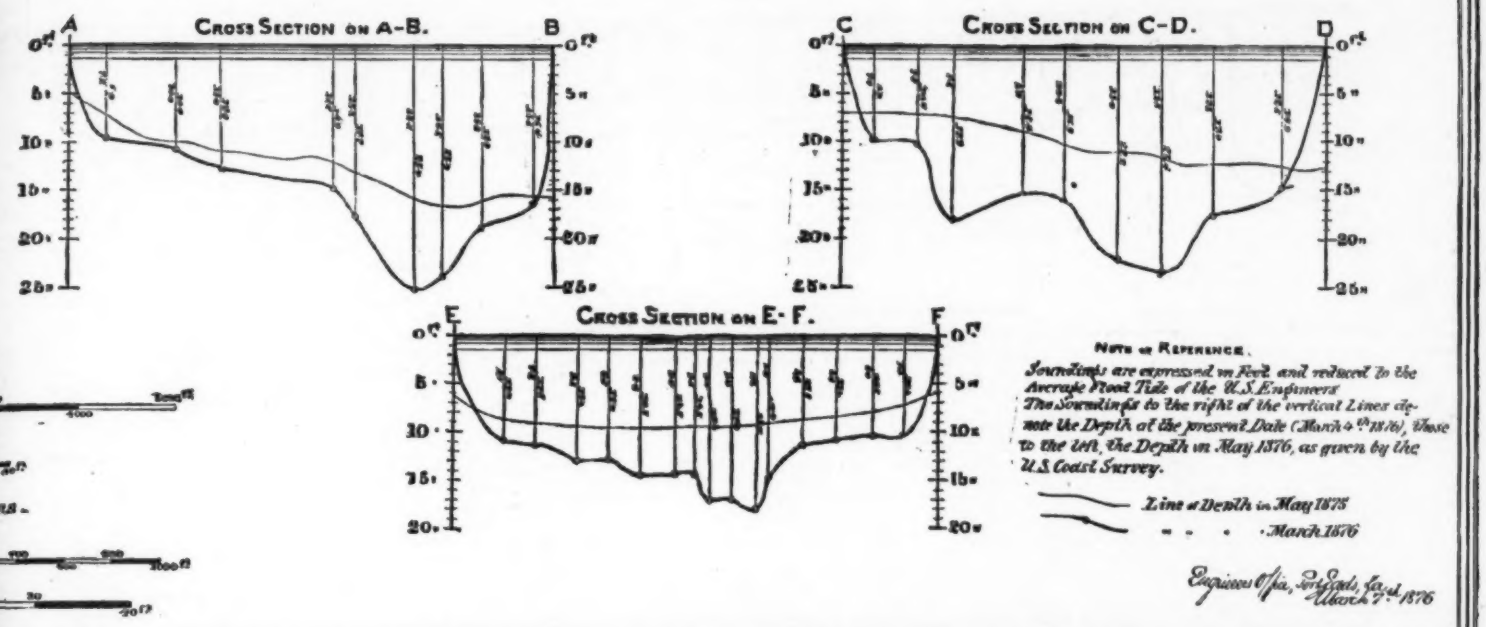
A brief *résumé* of the history of the enterprise, with a short description of the locality, will serve as an introduction to our subject.

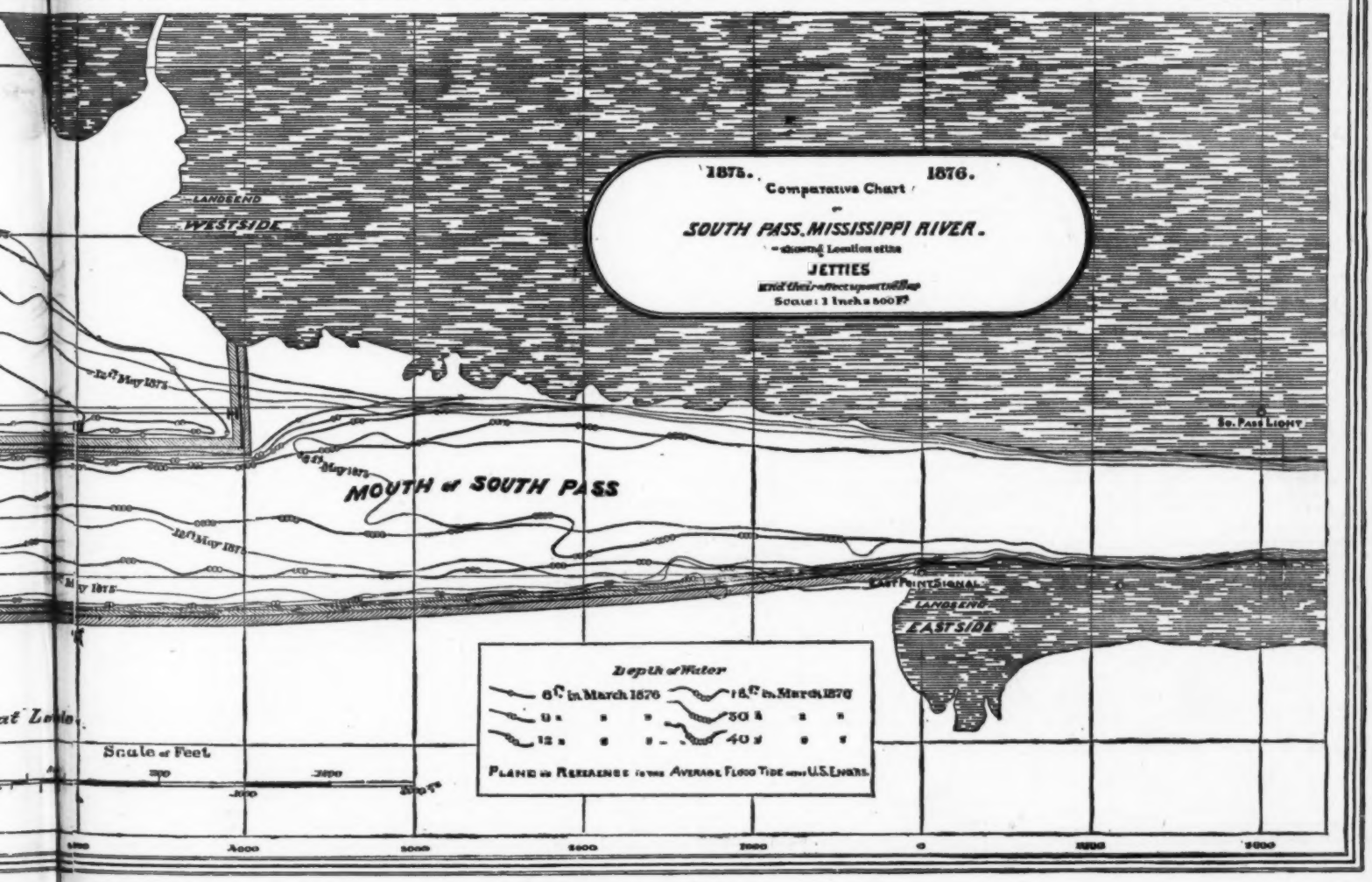
The great necessity of an open river-mouth to supply the transportation wants of the Mississippi Valley had long been felt. The national importance of the subject had been generally acknowledged, it had been discussed at different periods by the able advocates of the various plans proposed, and large sums of money had been and still are expended annually in endeavoring to open, and keep open, a channel by means of a dredge-boat. In the mean time the impatient vessels awaiting each their turn to go in or out, and delayed days, and sometimes weeks, by the futile attempt of a dredge-boat to overcome the action of a mighty river, are a common and annoying spectacle, while the storehouses of the great valley are filled with grain, cotton, rice, and sugar waiting for cheaper transportation.

When at last the whole valley of thirteen great and growing States demanded that the barriers should be removed by some means, Captain Jas. B. Eads, who had just united the East and the West by a magnificent bridge over the Mississippi River at St. Louis, conceived the project of opening the mouth of the river by jetties.

Having satisfied himself that his project would be successful, from an examination of the jettied rivers of Europe, and from a long and intimate and practical acquaintance with the peculiar characteristics of the Mississippi River, he fought his idea through Congress, and on the night of the 3d of March, 1875, was authorized, at the sole risk of himself and associates, to undertake the great work of deepening, by jetties and auxiliary works, the channel through the bar lying between the South Pass and the Gulf of Mexico.

For doing the work necessary to accomplish this he was to receive no compensation until he had secured a depth of twenty feet through the bar. Against opposition most powerful and bitter; in the face of sneers and doubts expressed on every hand; supported only by a few friends, who believed in him and in his idea; strengthened mainly by his own great faith in the success of his plan, so well founded in reason and so closely in accordance with the known laws of the river—he not only converted to his views many doubting minds, but also raised the necessary means for


A
Cross Section on A-B.
B
0ft
5
10
15
20
25
C
Cross Section on C-D.
D
E
Cross Section on E-F.
F
Note of Reference.
Soundings are expressed in Feet and reduced to the Average Flood Tide of the U.S.Engineers
The Soundings to the right of the vertical Lines denote the Depth of the present Date (March 4th 1876), those to the left, the Depth in May 1875, as given by the U.S Coast Survey.
Line of Depth in May 1875
March 1876
Engineers Office, Jetty Cuts, La. March 7th 1876



VER, WING THE LOCATION OF THE NEW JETTIES.

ing his work in a most depressed financial condition antry.

markable effects of the jetty-works thus far, which erated in this paper, are the results simply of the sineering plans and of the energy, the perseverance, roism of one man.

at river—receiving so many tributaries large and tching out its hands for a cooling draught from the nd the lakes that nestle among the perennial snows ky Mountains; in its insatiable ambition contend- the Red River of the North for the rain-drops and that fall upon the narrow ridge that away up on ern borders divides the water-sheds of these two ; grasping eagerly at the little rivulets and cas- leap down the steep slopes and precipices of the s, and, hungry for more food, cutting into the the western wilds; carving into deep cañons and hasms the mountain fastnesses of Colorado; rolling tumbling over and over the rocks dislodged by its torrents, till they become gravel; pushing forward g along the gravel till it becomes sand; mixing up, stirring about, and tossing hither and thither the sand, in its tumultuous course, till it becomes silt; foraging upon the lands that so dangerously lie along the banks of the angry Missouri; taking tribute from the farms of Western Pennsylvania and the prairies of Illinois; farther on gathering rich stores from the banks of the Lower Mississippi, it rushes past the Crescent City, a great, moving, inland sea, wide and deep and strong, a mighty, sediment-bearing river, loaded with the spoils of the great valley. Cutting and maintaining its deep channel through the alluvium, it moves seaward with the triumphal march of a conqueror.

Thus far the great river has found no obstacle capable of resisting its united power; but on arriving within a few miles of the blue waters of the gulf, and seeing itself flanked by this many-sided attack, it divides its forces to meet it, marching them by three main routes to meet the enemy—one to the right, one to the left, one straight forward. These in turn, when meeting the sea, divide their forces to prevent themselves from being flanked. By following these tactics they lose the day, but where the ranks are the longest held together, there the deepest inroads are made into the enemy's lines. Having lost its attacking power by a dispersion of its forces, defeated, it lays down its arms and scatters, in the highway of commerce, the booty and spoil robbed from half a continent.

Captain Eads is simply the ally of the great river. The South Pass having been selected as the line of attack, he calls in a division from the force moving to the sea through Pass à l'Outre, countermarches the column, pushing down Grand Bayou, and drives into line the demoralized host of stragglers that have lost themselves over the shoals and bars at the mouth of the pass. Like a great field-marshal, he forms them into a close column of advance and moves it onward to the attack, cutting its way thirty feet deep into the opposing bar to give marching-room for the crowded ranks, and hurling them, by the very momentum of the compact column, far out into the enemy's country—in one year stealing a march of centuries upon its old adversary, and opening to the nation's commerce the mouth of the great river for the vessels of the world.

Let us examine the field of operations and see what work it is necessary to do.

THE PASSES OF THE MISSISSIPPI.

The passes into which the river divides itself, about twelve miles above the gulf, are the South-west Pass to the right, Pass à l'Outre to the left, and the South Pass directly forward.

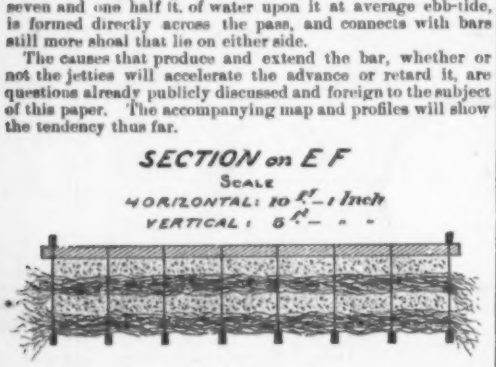
The latter is much the smallest of the three. A bar, wide and flat, having but fourteen and a half ft. of water at average flood-tide, stretches across the head of the South Pass This shoal, gradually deepening, extends a long distance up the river. The record of the changes that have taken place during several years past show that the shoaling is partially due to a crevasse about three miles above the head of the passes. This crevasse occurred during the war, and is still very wide and deep. In order to obtain a deep ship channel to the gulf through South Pass, it is necessary to deepen the bar at the head of the pass. Immediately below the bar the South Pass becomes at once much more narrow and deep, and assumes its normal cross-section. It is from six hundred to seven hundred ft. wide, and from forty-five to fifty-five ft. deep. The general course of the pass is a reversed curve, the reversing point being near Grand Bayou, where a volume is thrown out to the right that is about twenty-three per cent of the volume of the pass. This Bayou is about 275 ft. wide and 30 ft. deep. It is, in fact, a small pass in itself, with all the characteristics of alignment, cross-section, and flow of the larger passes. Its course is nearly parallel to that of the South Pass.

Below the bayou the pass is smaller in width and depth. Throughout its entire length it is a beautiful ship-canal, and while carrying to the gulf only about eight per cent of the volume of the whole river, is yet as large as many rivers on which the shipping is numerous and the traffic great.

The length from the head of the pass to the land's end at the mouth of the pass is about ten miles. Here the water commences to spread out to the left over a bar that extends for a mile towards the gulf. The western shore of the pass also recedes quickly. At a distance of 4000 ft. from the eastern land's end, the width of the pass is about 1700 ft., measured from the bar on the east to the shore on the west. The western shore now recedes more rapidly, and at a distance of 2000 ft. farther out there is no shore on either hand to confine the river water except a small reef on either side. It rapidly spreads out, losing its velocity, and consequently its carrying power, thus by deposits of sediment slowly forming shoals and bars.

In the central thread of the current the depth remains greater, and the velocity is retained by the momentum of the volume in the still deeper channel-way above. This velocity is soon lost by the gradual shoaling, and a bar, having but seven and one half ft. of water upon it at average ebb-tide, is formed directly across the pass, and connects with bars still more shoal that lie on either side.

The causes that produce and extend the bar, whether or not the jetties will accelerate the advance or retard it, are questions already publicly discussed and foreign to the subject of this paper. The accompanying map and profiles will show the tendency thus far.



A description of the surroundings as seen last June (1875) could all be summed up in three words—water, reeds, mud. With the exception of the light-house near by, no human habitation of any kind could be found for several miles; not even a fisherman's hut broke the monotony of the scene; but a small white flag here, a temporary platform there, a stake stuck in the stump imbedded in the mud, or a tripod on a mud-lump, were the only marks of civilization that met our eyes. These told us that the indefatigable Coast Survey had preceded us, and that each shore and bar, each reef and contour-line, each elevation and depression of the bed of the pass and of the bar had been carefully surveyed, mapped out, and prepared for us by those whose skill, accuracy, and patience have a world-wide reputation. The party of H. L. Marindin, of the U. S. Coast Survey, between fog, alligators, mosquitoes and sand-flies, had made a complete survey of the South Pass and bar.

The results obtained by them formed the basis of our work, on which all plans for location and construction were made.

The delta of the Mississippi is formed entirely by the sediment brought down by the river. The banks are slowly built up by the annual overflows, and at the mouth of the river by the almost daily overflows caused by the tides. These tides are diurnal in this locality; the range between mean low water and mean high water is about eighteen inches. The tides are very irregular in time and height, and they are greatly affected by the direction and force of the winds.

The climate is healthy and agreeable; the temperature during the summer is very uniform, scarcely ever falling below 75° Fahrenheit or rising above 90°; during the winter it seldom goes below 60°, except during the sudden and chilly "northers," when the temperature is often as low as 45° above zero.

The deep water close against the banks of the pass, the wharves and buildings already erected, the leveeing and draining of the land soon to be done, the salubrity of the climate, all conspire to make Port Eads a city that will rival many a flourishing sea-port, where storehouses and elevators for transhipment will be easily erected and conveniently located; where there need be no expensive levees to accommodate the business to a great rise and fall of the river; where ballast may be conveniently discharged, and where especially the expensive towage of sailing vessels up and down the river will be avoided.

Before locating the jetties or determining upon the plans for construction, the character of the foundation for the work was carefully examined. It was ascertained that the bar was sufficiently firm to hold up works of much heavier character than those contemplated. Experience afterwards gained in driving guide-piles for the work proved the bar to be even more compact than the preliminary examinations indicated. From the table given at the close of this paper, showing the power required to drive the piles, all fears as to the ability of the foundation to bear its load, or a much heavier load than will be placed upon it, may be set at rest.

A construction having a broad base and gentle slopes is best fitted to meet the exigencies that works exposed to the storms and waves of this locality must encounter from time to time, and which will try the strength of the construction. Economical considerations also led to the adoption of such a plan as is best adapted to the material on hand; namely, the willows so numerous along the river banks and along the bayous leading out of it. Very similar material, used under like conditions, and in nearly the form adopted, has been very successfully employed in the construction of jetties in Europe.

Before entering into the details of construction let us examine the location of the jetties, in determining which there were three objects in view:

First. To maintain between them a width that would insure a permanent depth of thirty feet.

Second. An economical location.

Third. To so direct the outflowing current as to give it the benefit of the strong westerly current that is found in front of the delta of the Mississippi, caused by the prevailing easterly winds.

The width determined upon was 1000 ft., which was afterwards approved by the Advising Board of distinguished engineers, whose judgment was solicited by Captain Eads upon questions concerning the location and construction of the jetties.

This width is about 300 ft. greater than the average width of the pass above Grand Bayou, but it is expected that the increased volume obtained by closing Grand Bayou will produce the required depth between the jetties. Captain Eads is of the opinion that the cross-section between the jetties will always be greater than that in the pass above Grand Bayou after the bar is removed from between them, on account of the inflow and outflow of the tides. For this reason the great width of 1000 ft. was determined upon by Captain Eads, by which greater security against undermining of the works is obtained. Should the width be found too great, the deflecting dyke at the head of the pass, now building to remove the shoal at that point, will supply any requisite quantity of water.

LOCATION OF THE JETTIES.

The guide-piling for the east jetty is the working-line for the location. It commences at land's end and skirts the edge of the bar for 9000 ft., which in a great measure protects the work from the waves of the gulf. Beyond this point the jetty is exposed to the full violence of storms and breakers.

The first objective point in the alignment is an old wreck of a schooner, located about 9000 ft. from land's end. This direction is followed for 1200 ft., when the line deflects to the right one ft. in 23 ft. This direction continues for 2800 ft. farther, where it again deflects to the right one ft. in 16 ft. for a further distance of 3130 ft., at which point a curve to the right begins, which has a radius of 16,000 ft. This curve is laid out in chords of 600 ft;, and continues to the present terminus of the work, which is 12,100 ft. distant from land's end, measured on the line of the jetty. The east jetty is generally in shoal water, never less than four ft. in depth nor greater than nine ft., except beyond the crest of the bar.

Assuming that the bar commences at land's end, it has an upward slope seaward averaging one foot in 400 ft. This ascent is very uniform until the summit is reached, where there is a plateau about 3000 ft. long. The depth on this plateau did not vary much from 7½ ft. at average ebb-tide. At the sea end of it there is a descent of about one ft. in 60 ft. to the deep water of the gulf. The guide-piles at the sea end of the east jetty are in 35 ft. of water.

The west jetty piling commences at a point 1000 ft. west of the east jetty, and 4000 ft. from land's end, on the east side, measured on the line of the east jetty. Its alignment is parallel to that of the east jetty, and is extended to a point nearly opposite to the end of the east jetty. The ultimate limit is in a line due west from the end of the east jetty. This arrangement throws the east jetty seaward of the west about 300 ft., to give a sheltered entrance to vessels. The piles in both jetties were driven as guide-piles only for the willow-work, and do not in any way form a part of the final construction. During the progress of the work they assist materially by forming a good anchorage and protection for the more important mattress-work laid against them. The west jetty is connected with the shore by a dyke of piling and willow-work.

It may be interesting to engineers to know the manner in which these lines were located. It is very easy to place on paper a curved or broken line as the location of work. It is not always as easy to go out on a broad expanse of water, often rough with breakers and waves, and lay down for actual work the lines corresponding to those drawn on paper. In this case the task was not rendered any the easier from the fact that we had no trained assistants, nor even a man that could be trusted to measure two feet with a two-foot rule. Fortunately we had one good Stackpole transit, which had performed fine work in the construction of two bridges over the Upper Mississippi, and in our estimation was in point of intelligence equal to two ordinary men. We were also fortunate in having three or four instrumental points that had been established by the Coast Survey, with angles carefully measured and azimuths calculated. An auxiliary instrument in the shape of an engineer's pocket sextant enabled us, with what we had, to get through the work passably well.

The bar on the east of the work was of great advantage; for by wading over this in mud and water we set back ranges so that a line from any deflecting point on the curve if produced seaward would be in the line of the chord to be driven. The distance between any pile, selected at random on the tangent above the curve and the point where the deflection was to be made, was obtained by careful triangulation. The distance from this pile, at right angles to the line of piling to a point which would be in the line of the chord to be set out, was obtained by calculation and by measuring in the water and squaring off with the sextant from the pile. A flag was set. This flag and the last pile on the chord just driven was the line of the next chord required. By this method, with other details that need not be mentioned, we were enabled to locate the last pile of the east jetty 12,100 ft. from east-point signal at land's end, with a possible error of one ft., as ascertained by the careful instrumental work of Captain M. R. Brown, U.S.A., who has immediate oversight of the work for the United States Government, under the direction of Major-General C. B. Comstock, United States Engineer.

The alignment of the west jetty was made by a process very similar to that used on the east jetty.

After the jetty-lines were established by driving the piles, permanent cross-sections were established about 500 ft. apart, ranges were placed on the piles on each jetty that came on those sections, and back ranges were set up on the outlying reefs, shores, and mud-lumps. By this system, aided by diagonal sections and corresponding ranges, we have been able by one instrument to locate every sounding made to show periodically the changes that are so rapidly occurring in the deepening of the bar. These comparative charts, profiles, and cross-sections afford subject matter for much study which is at once interesting and profitable.

PROCESS OF CONSTRUCTING THE JETTIES.

Having described the preparatory work, we will proceed to give some details connected with the process of the main construction—namely, the cutting, transporting, working up into suitable form, handling in the water, and putting in place, the millions of willows that constitute the jetties proper. The willow grows in greater abundance here than any other tree—not exactly in this vicinity, however, for we know of nothing worthy the name of tree within three miles of our works; but about 23 miles above here, in the newly-formed delta of an old crevasse called the "Jump," there is a growth of willows spread over nearly 30 square miles of new land.

The "Jump" is a wonderful place, where the river, forestalling the need of an open mouth, made a feint as if to open a channel to the gulf at this point; but it was only a feint; its ultimate object was to provide materials for the jetties. About thirty-six years ago, or in 1840, the "Jump" was a little, insignificant, artificial canal for fishermen, having a lock at the river bank. Here a break occurred through the soft alluvial banks of the river, and then quickly it became a mighty torrent 600 ft. wide and 50 ft. deep, into which a tug-boat, with its tow of two large vessels, was drawn by the force of the current. Thus it poured into the shallow inland bay, and through it into the gulf. A vast amount of sediment was carried in with the water, the most of which was soon dropped on the bottom, spreading out a delta of mud. Soon the reeds and grasses made their appearance above this half-submerged deposit. This growth checked the flow of the water still more, helped to build higher banks and to divide the flowing volume into many winding and gradually narrowing channels. When the banks had become somewhat higher, the seeds of the willow took root and sprang up, ten millions of them, and skirted the banks of all its intricate channels.

These willows have built the greater part of the South Pass jetties. Since the "Jump" crevasse occurred, thirty-six years ago, 90 square miles of territory have been made by it.

The cutting and loading of the willows is no pleasant occupation. There is deep mud everywhere, and during the flood season of the river a foot or more of water over the mud. To carry on the shoulder all day bundles of willows over a distance of 200 to 500 ft. soon gets to be monotonous, to say the least. In the daytime annoyed by the deer-fly that infests the willow-thickets, and in the night tormented by the most bloodthirsty mosquitoes ever let live. This must be the home of the mosquito; he emigrates from here to all parts of the country, but the home stock never grows less in numbers or in its power to inflict punishment upon its enemies. The willows, loaded on barges, are transported to the jetties by the steamboat Grafton, the skill of whose master, Captain Ruby, in navigating the crooked, shallow channels of the "Jump" is almost marvellous. The barges are landed against the launching-ways, on which the willows are worked up into the form peculiar to this work.

THE MATTRESSES.

The accompanying sketch, No. 2, in elevation, projection, plan, and detail fully illustrates this particular construction, which we call a "mattress." The ways on which the mattresses are made are simply an inclined plane made of timbers placed at right angles to the banks of the pass, with the lower end in the water and the upper about six ft. above it. The inclination of the timbers is about one in ten. They are placed, five ft. apart, on piles driven to the proper height, the tops cut to the bevel of the incline. On these timbers and lengthwise of them is a ribbon of 3" x 3" scantling. This is spiked to the timbers and has its upper surface adzed off to the width of half an inch. These ribbons are then well greased, a floor is nailed to the under side of the timbers to prevent the workmen falling through, and the ways are then ready for the mattress construction.

The material for the frames of the mattresses is piled up just above the ends of the ways. These strips are 2½" x 6" and from 25 to 45 ft. long. The mattresses being usually 100 ft. long, the strips are cut to make that length when joined. They are placed on trucks and wheeled to that part of the ways where the mattress is to be built. After being lifted upon the ways the joints are fastened by a lap of the same material about six ft. long, and spiked to the strips. If the mattress is to be 40 ft. wide, nine strips are prepared. Holes are now bored through these strips which are 1½" in diameter and spaced five ft. apart. Hickory pins, whose ends have been turned to fit the holes tightly, are driven into them, and oak wedges driven into the lower ends of the pins. The strips, with the pins standing upright, are moved down the ways and spaced four ft. and six inches apart. If the mattress is to be two ft. thick, the usual size, the pins are cut 30" long, except the outer row on either side, which is 32". A part of the mattress-gang now climb upon the willow-barge and pass the willows down to other workmen standing on the frame, who place them carefully side by side on the strips across the frame. After a course about 6" is placed, another is laid lengthwise with the frame, then another at right angles to the last, and so on till the willows stand above the tops of the pins. In placing the willows, the brushy tops are laid so as to project three or four ft. outside the frame.

The willow-men now commence another mattress, and another gang, having bored holes to correspond with the upper end of the pins, in strips about forty ft. long, place them across the mattress and insert the pins into the holes—pressing down the cross strips with levers. Wedges are driven into the ends of the pins, and the mattress is then ready for launching. To prepare for this a line two inches in diameter is placed under the frame before the willows are placed on it. The ends are left free near the corners of the frame and just behind it, till the cross-binders are put on, when they are brought up over the edge of the mattress and made fast to a binder. The loop of the line is brought down to just outside of the lower strip, and brought up beside one of the pins and tied to it with rope-yarn till the mattress is ready to launch. In the same manner two head-lines 1¼ inch in diameter are placed under the upper end of the frame and tied to the pins till after the mattress is built, when toggles are placed across the willows and the head-lines are made fast to them; a check-line is fastened to the toggles so that the head-line can be drawn up through the mattress after it is placed.

The mattress is easily pulled off the ways by the tug, which tows it to its location on the line of the jetties. To place a mattress just where it should go is sometimes very difficult work. A swift current, a rough sea, or an adverse wind is very troublesome. The two foremen, whose business it is to launch and place the mattresses, scarcely ever make a mistake, so well trained are they in this peculiar work. The mattress having been tied to the piles, a stone-barge is brought

alongside, and the mattress is sunk to its place either on the bed of the river or on other mattresses previously sunken.

This minute and perhaps tedious description of a mattress is given because it is the principal construction used on the jetties and the auxiliary works at the head of the pass and at Grand Bayou. It has so well proved its usefulness and adaptability to dykes on rivers and sea-coasts that Capt. Eads and Col. Andrews, the joint inventors, have taken out a patent for it, and it is expected that it will be used almost altogether for the great work in prospect at no distant day—namely, the dams, dykes, and revetments necessary to secure twelve feet of water between St Louis, and New Orleans.

The cross-section of the jetties and the manner of construction differ greatly at different localities, but the general plan proposed for the finished work is shown on the accompanying sketch (No. 2.). A mattress two feet thick and from 35 to 50 feet wide is laid on the bar for a foundation. On this other courses are laid of less width but usually the same thickness, each course being sunk and securely held in place by rock. When the slope of the bed between the jetties shall have been formed to suit the new cross-section, and when perhaps the edge of the foundation mattress has dropped down to meet this slope, another mattress will be laid on the slope and against the edge of the foundation mattress.

The whole surface of the mattress exposed will then be covered with rock; dimension-stone laid dry but close together will form the crown of the jetties and will appear above the water. At the sea ends of the jetties special plans will be made which, with a broad base, long easy slopes, and a covering of heavy stone, will insure the permanency of the construction.

There are minor and somewhat temporary constructions that require only a brief mention. The first is a mile of sheet-piling put in under the protection of the bar extending seaward from lands end.

MODE OF DRIVING THE PILES.

The method of construction was as follows: Piles of 12″ by 12″ timber were driven in two rows, the piles 8 ft. apart, the rows 12 ft. apart. Against the sea side of the river row a waling-timber was securely bolted. Two pile drivers mounted on travellers moved on the tops of the piles and drove the sheet-piles close against the waling-timber. The piles were 5″ by 12″ at the upper end, and 3″ by 12″ at the lower end. They were driven about twelve ft. into the ground, and cut so that, when well driven down, the top of the pile would be flush with the top of the waling-timber, or two ft. above mean low water. The piles were driven as close together as practicable, and were well bolted to the waling-timber and the main piles. One of the drivers was an ordinary pile-driver with a few peculiarities to make it suitable for this work.

The second machine had a hammer of peculiar construction, which was attached to a wooden stem about 20 ft. long and so connected with it as to lessen the shock of the blow on the wood. This stem was lifted by friction rollers 1 ft. in diameter, and thrown against or away from the hammer-stem by a brake attached to a steam-piston which was worked by a hand-lever. By this arrangement blows could be struck in quick succession. The maximum number of piles driven by this machine in one day was 176, with two hours delay in waiting for piles. If well manned and supplied with piles promptly, a much greater number could be driven.

A second temporary work was the construction of wooden aprons along the lines of the west jetty for 3000 ft. from the upper end, and on the dam connecting the upper end of this jetty with the west shore. This dam caused a head of water of eight inches during the ebb of a high tide, and with the construction of the aprons along the west jetty caused a deepening between the jetties. Three weeks after the dam was completed the deepening was found to be as follows: on the line of the dam produced, 150 ft. beyond the west jetty, 4 ft.; 1000 ft. seaward, and 240 ft. from the west jetty, 5 ft.; 1000 ft. farther seaward, 140 ft. from the west jetty, 5 ft.

Having described the location of the jetties and the plans for construction, a history of the work briefly given may not be out of place; after which it may be interesting to know what results have been obtained thus far, and what amount of material has been used to produce these results.

THE INDIVIDUALS ENGAGED IN THE WORK.

Soon after the passage of the act authorizing the construc- of the jetties, the contract for the entire work was given to James Andrews and Co., of Allegheny City, Pa.

The long and successful experience in the construction of some of the most important works in the country eminently fitted Col. Andrews for this work. Col. Andrews had made a personal examination of many of the jetties on European rivers, and had a large experience in river work. No wiser selection of a contractor could have been made by Capt. Eads, for with his experience he was noted for having several qualities that are invaluable on a work of this kind—namely, executive ability, perseverance, and tremendous energy.

Capt. Eads associated with himself, as resident engineer, Mr. G. W. R. Bayley, of New-Orleans, whose long and varied experience in railroad and levee work in Louisiana gave great weight to his advice. Appreciating the dangers and difficulties of the work, and having a sound judgment and an extensive knowledge of river hydraulics, his assistance in the determination and prosecution of the plans for construction have been of great service.

The services of Mr. Max E. Schmidt, who had been connected with the government surveys of the rivers of the Northwest, were also secured. The map and plan accompanying this paper are made by him. With wise forethought Col. Andrews obtained the services of several foremen who had previously been in his employ in the construction of the St. Louis Bridge. Their experience and faithfulness have been of great advantage to this work.

The circumstances that surrounded the work at first were by no means pleasant, and the difficulties that beset it were by no means small. During the summer we were hampered, delayed, harassed at times almost beyond endurance, with no regular communications with our base of supplies at New-Orleans by rail, or boat, or telegraph. Put out here in a great mud-swamp—an amphibious marsh—in which we floundered about and worked under the greatest disadvantage, unable to obtain but few good laboring-men, and obliged to pick up the worthless idlers that lounged about the levees of New-Orleans; with no shops or wharves; with few tools and no machinery for repairs; short of barges for stone and willows. Thus the whole summer passed before the force was well organized or any system could be evolved out of all this chaos; yet with all these troubles and difficulties the work of construction went on, and by the 14th of August—two months after landing here—we were building daily 400 lineal ft. of mattresses, and there had been laid in place 3000 lineal ft. The piling on the line of the east jetty had been driven out 8200 ft., mattress-ways had been constructed sufficient for the rapid prosecution of the work, houses had been erected for the workmen, walks and wharves were well under way, a large amount of material was on hand, and every thing in fair condition for work.

The prosecution of the work was very much aided by the prompt payment of wages and by the confidence given to the enterprise in New-Orleans by the prompt payment of all dues for material purchased or work done. As to the results that have from the beginning followed the prosecution of the work, they can be thoroughly understood only by a much more complete exhibit than can be given in this paper—already extended too far.

As preliminary to the statement of facts by tables and the accompanying map, it may be stated that in the case of all sediment-bearing rivers while passing through their delta, the volume of water moving, the slope of the surface, the velocity of the current, and the cross-section of the river-bed are all in perfect equilibrium. If one element is changed, a corresponding change occurs in all the others; remove a portion of the volume, and immediately the cross-section diminishes in depth or width or both: the velocity of the current is less and the slope increases. On the other hand, increase the volume either by deflecting into the river more water or by forcing the same volume into a more contracted channel, and opposite results follow at once: the cross-section enlarges in width if it can; if not, in depth; the velocity of the current increases and the slope diminishes. During the progress of the work the placing of one mattress has been observed to cause a deepening near it and extending below it, so that where the tug could not go yesterday on account of the shoal water, there is plenty of water to-day. Even the line of open piling driven in advance of the works caused a deepening of the pass extending from land's end to near the end of the piling. This scouring action extended to the centre of the pass, and was not confined to the vicinity of the piling. In short, every pile and sheet-pile, every mattress and stone placed along the line of the jetties has produced a deepening somewhere.

GENERAL OBSERVATIONS ON THE PROGRESS OF THE WORK.

It has been a most interesting study to trace the changes occurring constantly as the work progresses; to note the advance of the contour-lines of deep water, and the manner in which the volume of water, more and more confined in width, deepens for itself its passage to the sea. For instance, at one point, where probably the material composing the bar was softer than elsewhere, a deep but narrow excavation is noticed. The current, quickened yet more by the increased depth, has more power to move the material. At the next examination, perhaps only a week later, a deeper scour is noticed, and a very sensible wearing away of the sides of the excavation is shown on the cross-section, and 500 ft. seaward a faint trace showing the deepening to have extended to this point also. The next examination shows deepening and widening in both cross-sections, and its appearance still farther on.

Many illustrations could be given to show that the constant tendency is toward a deep, wide channel through the bar, and, in brief, that the river has been turned from an abnormal occupation to its proper and legitimate work of channel-making.

It has been quite as interesting to follow the process of deposition on the sea side of the jetties; the most remarkable change of this nature has occurred west of the west jetty. The entire basin between the jetty and the outlying shoals and reef is rapidly filling up. Where last September a steamboat drawing nine feet of water could run with ease, a skiff now grounds at high tide.

The material thus deposited is by no means soft mud, but a hard-packed, fine sand, thrown over the jetty by the river and then hurled in against it by the waves; or, escaping from the ends of the jetties, driven in by the breakers and piled up to the very summit of the construction—a firm, wide, enduring protection, against which the sea will beat in vain and every attempt to overthrow it will lend new strength to its resisting power.

The auxiliary works at the head of pass and at Grand Bayou need but a passing notice, as they are both in the earlier stages of construction.

The location of the deflecting dyke at the former place was very carefully considered by the Advisory Board of Engineers.

The work is still partly experimental; if it does not accomplish all that is desired, it may be extended farther up the river, with perhaps an auxiliary dyke on the west side of the pass.

The present length of the dyke is 3250 ft., commencing at the shore on the east side of the pass and terminating in 24 ft. of water.

The foundation mattresses have been laid 2650 ft. from the upper end, and a second course 2050 ft. A line of guide-piles was first driven the entire length, from 8 to 20 ft. apart. On the Pass à l'Outre side an apron of mattresses 20 ft. wide has been laid for 2000 ft.

The mattresses for this work are constructed at the "Jump," and towed to the dyke by a steamboat.

The volume intercepted and deflected into South Pass will not only deepen the bar at the head of the pass, but will be a powerful auxiliary in deepening the bar at the mouth of the pass.

At Grand Bayou a dam is to be constructed, which will throw the entire volume into the pass. This dam has its foundation of mattresses laid, and the work is being rapidly prosecuted.

The present state of the work at the jetties is as follows:

On the east jetty the sheet-piling and mattresses—the latter having generally been raised to the surface—prevent the extravasation of nearly all the water attempting to pass over the bar in this vicinity.

From the end of the sheet-piling for nearly a mile the work is raised to average flood-tide. The mattresses extend about 900 ft. farther, and are from 4 to 10 ft. below the surface. The mattress-work is extended to a point 11,800 ft. from east-point signal and over the crest of the bar.

At the west jetty the cross-dam to the shore is raised to average flood-tide. From the head of the west jetty, for about three quarters of a mile, the apron and mattress work confine the water on this side. From the end of the apron-work to a point 6000 ft. from the head of the jetty, the work is at the height of average flood-tide. From this point to the present terminus of the mattress-work, 7700 ft. from the head of the jetty, the work is from 3 to 8 ft. below average flood-tide.

The condition of the works at Port Eads and elsewhere, and the amount of plant and transportation facilities, is as follows:

1250 lineal ft. of ways for constructing and launching mattresses.

500 lineal ft. front of wharves.

Blacksmith, machine, and carpenter shops, well supplied with tools.

2 floating pile-drivers.

2 sheet pile-drivers.

Accommodations for 350 workmen.

Head-quarters' hotel, 60 feet by 100 feet.

2 powerful stern-wheel steamboats.

1 tug.

1 steam yacht.

3 steam launches.

12 large model barges.

2 flat-boats and 4 small flats.

To exhibit a few of the changes that have occurred, and the results thus far obtained, the following tables are given, with a table added to show the character of the material on which the jetties are built.

TABLE I.

LENGTH OF CONTOUR LINES OF SOUNDINGS THROUGH THE BOX.

	Length in May, 1875.	Length in Dec., 1875.	Length in Jan., 1876.	Length in Feb., 1876.	Length on Mar. 7, 1876.	Length on Mar. 30, 1876.
	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.
12 foot contour.....	4305	2635	750	.....		.....
15 foot contour.....	5925	4400	4175	2175	450	90
18 foot contour.....	7000	5692	4480	3060	2575	775
20 foot contour.....	9035	6215	5425	4490	3250	3000

TABLE II.

VOLUME OF BAR REMOVED BETWEEN CERTAIN DATES.

To December, 25th, 1875..	1,363,222 cubic yards.
From Dec. 25th to Jan. 27th, 1876.....	163,321 " "
From Jan. 27th to Jan 31st, 1876.....	30,000 " "
From Jan. 31st to Feb. 17th 1876.....	11,846 " "
From Feb. 17th to March 4th, 1876.....	233,314 " "

Total amount moved from May, 1875, to March 4th, 1876.....1,791,703, or 7200 cubic yards daily.
Amount of material deposited west of west jetty, 1,000,000 cubic yards.

TABLE III.

TABLE SHOWING CHARACTER OF FOUNDATION AND RECORD OF PILE DRIVING.

Location of piles.	Weight of hamm'r	Aver'ge fall of hamm'r	Aver'ge No. of blows.	Average depth driven.
EAST JETTY:	Lbs.	Feet.	Feet.	Feet.
From 4200 ft. to 5500 ft.....	3000	15.5	17.6	16.7
From 7300 ft. to 12,100 ft.....	3000	15.5	44.0	16.7
From 9100 ft. to 9300 ft.....	3000	18.6	98.	17 4
From 11,900 ft. to 12,100 ft....	3000	19.0	44.9	28.2 across the crest of bar.
WEST JETTY:				
From end to end.....	3000	19.5	79.7	19.5

Since the examinations were made which are the basis of the accompanying map, many changes have taken place in the depths on the bar, as shown by the last column in table I.

The power of the current to deepen the bar has by no means reached its limit.

It is confidently expected that a deep and voyageable channel, sufficient to accommodate the largest vessels, will soon be obtained.

As this result is likely to happen during the present Centennial year when the nation is girding itself anew for the greater conquests of another century, no more cheering event can happen, and no greater incentive be given to the agricultural growth of the country than the opening of the mouth of the Mississippi river to the commerce of the world.

It will be the harbinger of great good to the whole country and the awakening into a new, more vigorous and more healthy life all the dormant energies of the Great West and Southwest, and henceforth it may be said with greater truth than ever before, "Westward the course of empire takes its way."

E. L. CORTHELL,
Chief Assistant-Engineer of South Pass Jetty Works.

ERYTHROXYLON COCA.

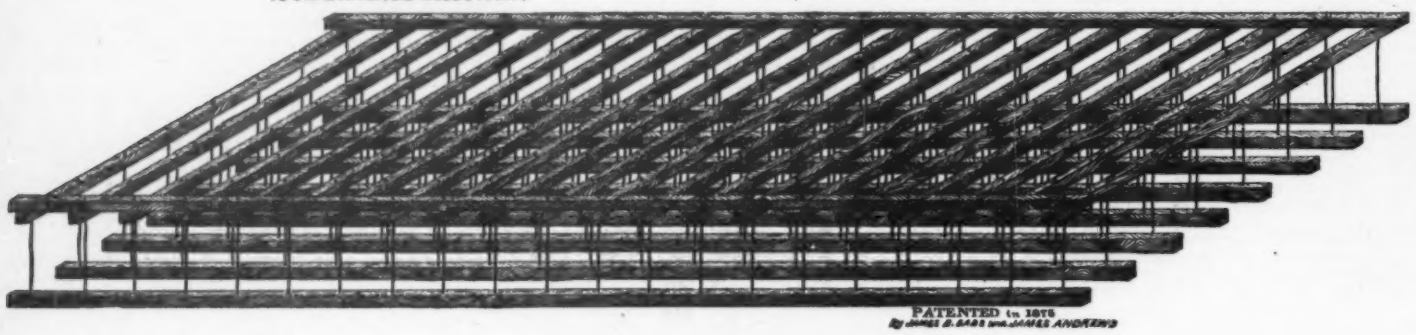
THE Eucalyptus came in some time ago as a subject of newspaper small-talk, and now one of the medical newspapers has started this plant, which is a shrub indigenous in Western South America, where it is largely employed by the natives as a sort of vital stimulant. The South American Indians use the coca leaves in the same way as the natives of the Eastern Archipelago use the betel-nut, making them up into a ball with pulverised unslaked lime and chewing them. Von Tschudi, in his narrative of travel in Peru gives a wonderful, but apparently trustworthy, account of the powers of this drug. He states that, having employed an Indian, sixty-two years of age, in laborious work for a period of five days, the man during that time never tasted food, and took only two hours' sleep nightly. But at intervals of two and a half or three hours he regularly masticated about half an ounce of coca-leaves. Von Tschudi personally proved the efficacy of an infusion of the leaves as a preventive of the difficulty of respiration and debility experienced in the rapid ascents and rarefied air of the Andes. He compares the effects of coca to those of narcotics administered in small doses, and although he considers the notions of the Indians respecting its virtues exaggerated, he is strongly of opinion that in moderate doses it will be found useful. Long before Von Tschudi's visit the Jesuits had appreciated these virtues, and so early as the seventeenth century recommended its introduction into Europe. The leaves of Erythroxylon have latterly been occasionally used in medical practice in England, and Dr. Tibbles, an American physician, records in the *Standard* of Monday one or two interesting cases of nervous debility and consumption in which the drug was employed with remarkable effect, and asserts that he has cured hundreds of similar cases in the same way. Dr. Tibbles says he has seen no authenticated account of death from excess in coca-eating; indeed, one of Von Tschudi's examples of free indulgence in this particular vanity was reputed 130 years old; so that if the coca is a poison it must, as the centenarian Scotch gypsy observed from his experience of whiskey, be remarkably slow in its operation.

MATTRESS FRAME

ISOMETRICAL PROJECTION.

HORIZONTAL SCALE 10 ft. = 1 Inch

VERTICAL SCALE 5 ft. = 1 "



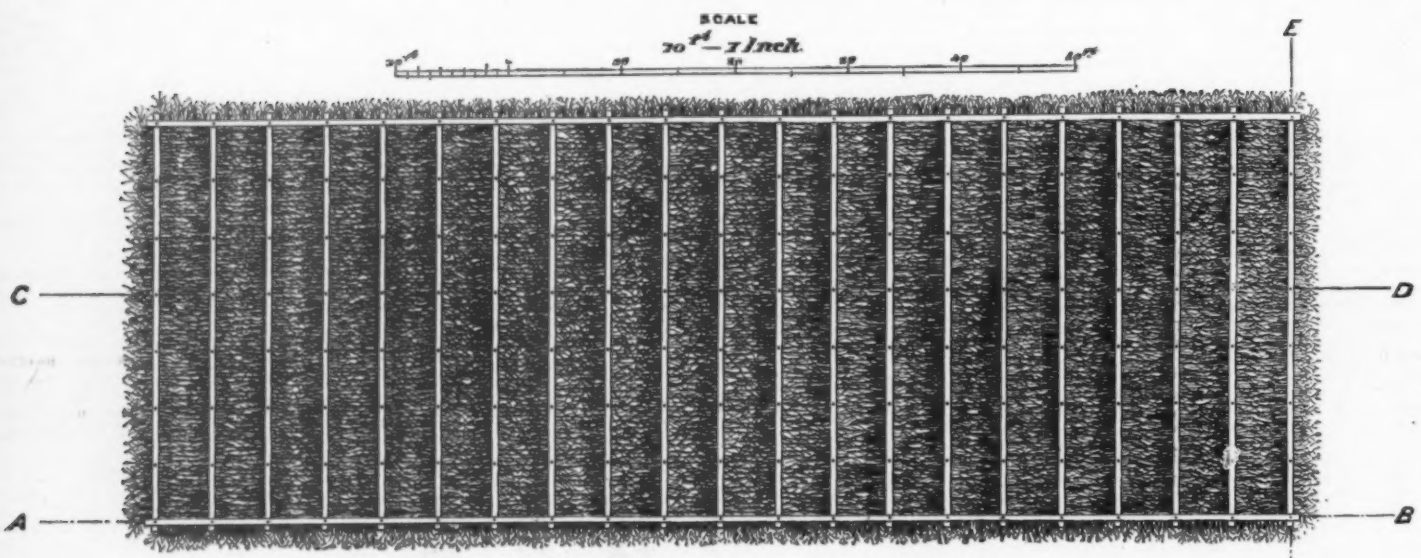
PATENTED in 1875

PLAN of MATTRESS

700 × 35 × 2

SCALE

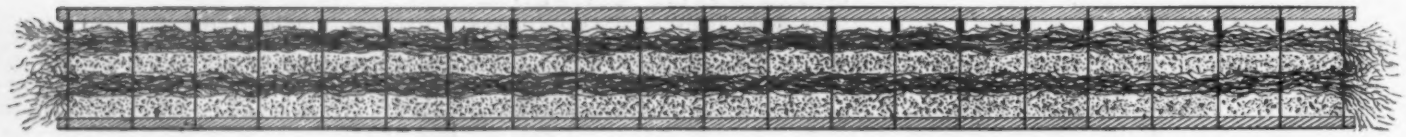
70 ft. = 1 Inch.



SECTION on A B

SCALE

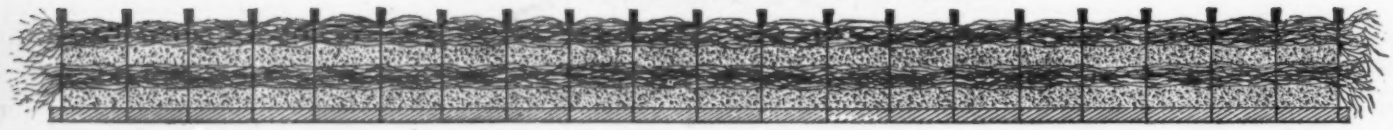
HORIZONTAL: 10 ft. = 1 Inch, VERTICAL: 5 ft. = 1 Inch



SECTION on C D

SCALE

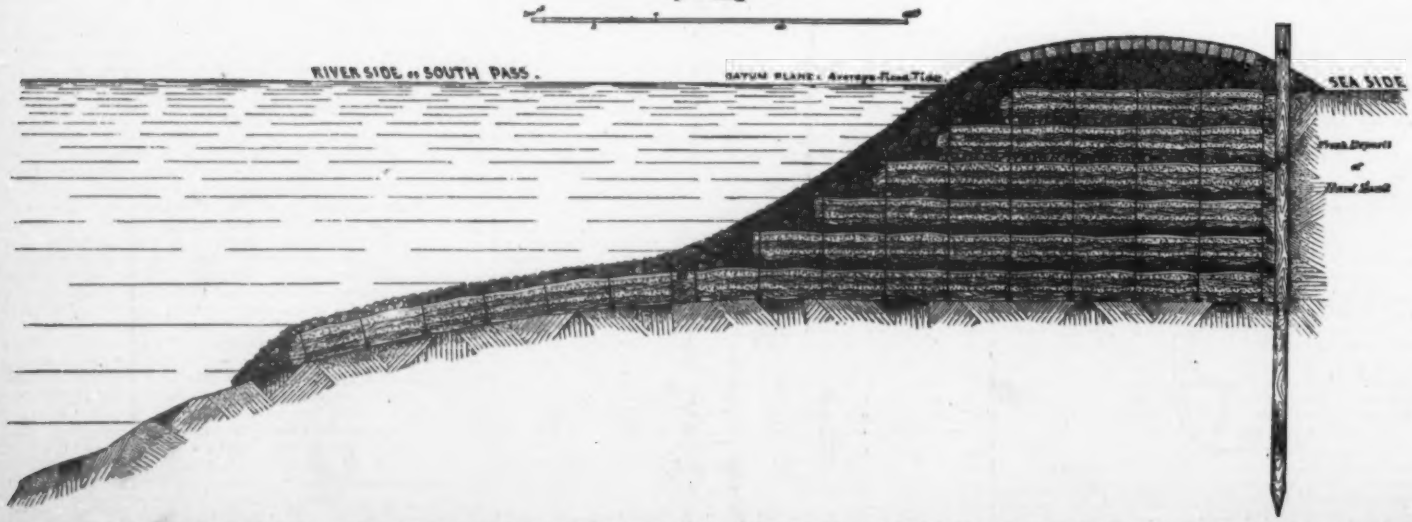
HORIZONTAL: 10 ft. = 1 Inch, VERTICAL: 5 ft. = 1 Inch



"THE FINISHED JETTY"

SECTION in 17 Feet of Water

Scale



CONSTRUCTION OF THE MATTRESSES AND JETTIES, MISSISSIPPI RIVER.—(*See page* 330.)

[Journal of the Society of Arts.]

ENGLISH RAILWAY COUPLINGS.

As the subject of railway car-couplings has of late occupied special attention in this country, the following, from a paper recently read before the Society of Arts, London, by T. Atwood Brockelbank, entitled "Improvements in Railway-Couplings as a Necessity of the Day," may not be uninteresting:—

Inventive minds in America, Belgium, Canada, France, Germany, Russia, Spain, and in some of our colonies, have exercised themselves in this direction.

America, of course, is behind no nation. Car-coupling inventions with them are reckoned by the thousand. In this country we reckon by the hundred (barely two hundred), and Germany follows.

As we progress, some of the reasons why no change has been made in this country will become evident, and the retention of the old hook-and-chain, which is substantially the same as it was fifty years ago, may not appear so wanting on the part of the railway companies as it has hitherto seemed to some people.

Before we plunge into a consideration of the remedies offering, we will, for easy reference, jot down what are the requirements of traffic which must be fulfilled in this country, and having these well in view, we will proceed to examine a few types.

The most important point of all, as I take it, is to do away altogether with any necessity of servants being engaged in the coupling of vehicles, and for this purpose an automatic connection is imperatively needed; again the uncoupling must be accomplished without any necessity for servants going between the vehicles, consequently any gear we put must work from either side of the vehicle. Of course, we must be able to connect and retain our hold, and to disconnect equally well on straight roads, on inclines, and on the very sharpest curves. Moreover, as there are now nearly a million of vehicles, engines, passenger-carriages, horse-boxes, wagons, both companies and traders in this country, immediate alteration is impossible.

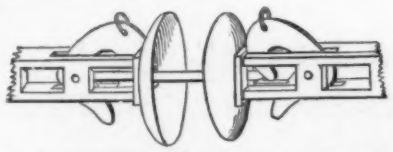
When we have dealt with the vehicles themselves, we get face to face with that eternal subject of conversation in this country—you will anticipate my allusion—I mean the weather; even snow in June is not unheard of, and if our coupling be one needing nice adjustment, say working by springs or counter-weights, or even requiring that hinges should work smoothly, rusting will inevitably bring it to grief some time or other, even if it survives concussion and vibration; the force and effect of the latter any one who has experienced the delight of sitting in a brake carriage which is defective needs not to be reminded of. These provided for, the importance of tightening up the passenger carriages must be considered, and to crown all, mechanical ignorance on the part of those employed in working it has to be borne in mind, and we may safely conclude that unless our coupling is one that the most ignorant shunter can not mistake, we shall be in a strait.

To enable you to follow me with ease, I place before you in order the coupling requirements of English traffic. I take them to be:

1. Gradual replacement.
2. Retention of spring action of draw-bars. Allowance for —Different heights of vehicles. Variety of buffers. Loading and unloading.
3. Weather—frost, snow, fog.
4. Night, darkness.
5. Working on sharpest curves.
6. Easy disconnection under all circumstances.
7. Tightening of passenger carriages.*
8. Simplicity, a main characteristic.

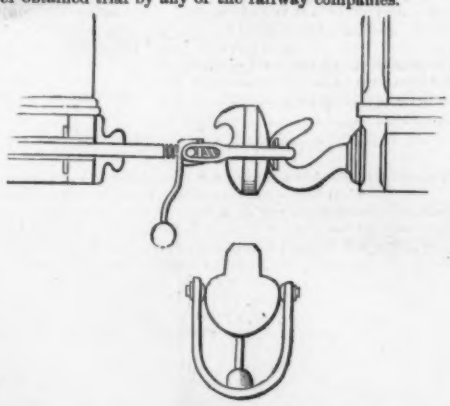
We will now proceed to consider some different types of couplings.

The earliest patent record in this country is dated 1825, and with the chain and hook about that date generally adopted, we now find ourselves surrounded. There are a few exceptions in this country: they are notably—the Pullman car, which, as a coupling type, stands alone; there is the connection on the Festiniog Railway, narrow gauge; one other, which I believe is common to the Isle of Man, the Isle of Wight, and the Sutherland railways; and on some of the Brighton trains there is a central buffer connection, and in the close-coupled trains of the Underground lines, and the Charing-cross lines and North-London railways, London. In 1847, or nearly 30 years ago, a link and pin connection, much the same as that now in use so generally, was patented.



In the following year an invention was patented which is worth attention; in lieu of a pin to hold the link, the inventor designed a hook of novel shape, hung upon and revolving on a pin, which, on collision, rose and dropped into the link. I think you will agree with me it is not equal to the link-and-pin connection.

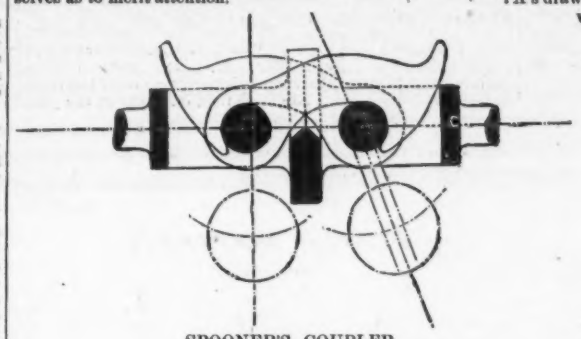
In 1854, a very sanguine inventor proposed to connect vehicles by means of a piston working in an oil-chamber; the idea was original and ingenious, but I should hardly think it ever obtained trial by any of the railway companies.



* In England, on passenger trains, little or no play is allowed between the couplings; the ends of the buffers, of which there are two on each platform, must be held tightly together.

In this we have an inventor whose soaring imagination is apparently far in advance of his practical knowledge; here is an attempt at a combination of centre buffer, loop, our old friend the hook, and a tightening apparatus. The loop, which is to be hinged to the buffer, has first to be placed over the hook, then by revolution of the screw the loop is drawn in, and the vehicles are tightened up.

Since 1861 about 150 couplings have been patented in the country, and these may roughly be said to resolve themselves into four or five different types. Of these types or classes I select one each for illustration, but before we do this, I will illustrate two inventions, which, although they are unsuitable to the general traffic of this country, are so complete in themselves as to merit attention.



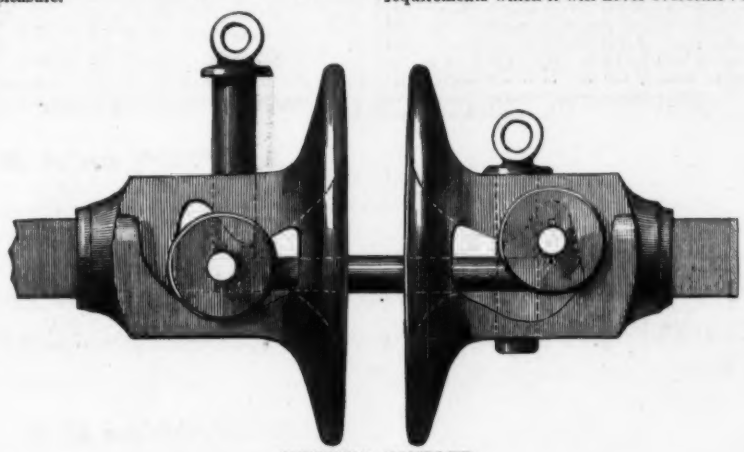
SPOONER'S COUPLER.

The first is that adopted by the Festiniog Railway in Wales. It is the invention of Mr. G. Percival Spooner, and I am given to understand it is the only continued buffer and draw-bar that will couple together, and I am assured it works well.

The combined arrangement of draw-bar, buffer, and coupling consists of a round rod of sufficient strength, having a suitably shaped head of the forked form to admit a coupling link or hook connecting one to the other without interfering with it when buffing; at the other end is a spring box, so arranged that whether drawing or buffing, a spring action is obtained. Each buffer-head is fitted with an eccentric and hook, and the coupling can be effected with both hooks as shown on drawing, or only one.

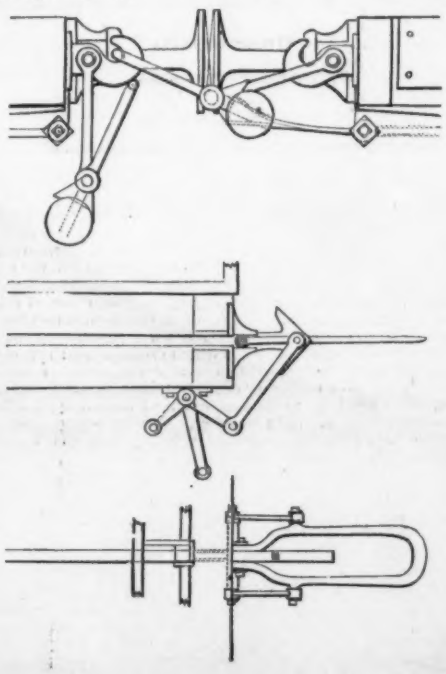
When it is desired to couple, the coupling weight should be lifted up until the hook or hooks will pass over the eccentric-pin, and then allowed to fall back again; this it will do to nearly its lowest position.

One end of a light chain is attached to each hook, the other being fastened to the carriage; by this means the hook can be more readily lifted up for the purpose of uncoupling, or suspended at pleasure.



STERNE'S COUPLER.

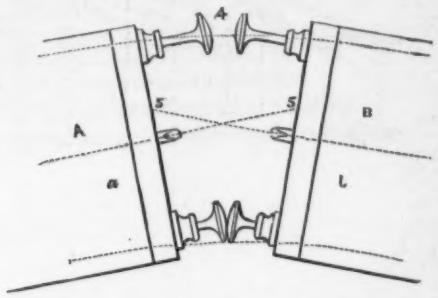
The second is one patented by Mr. Louis Sterne; this, as far as I know, is most original in getting first at setting the pin in position, then by the shape of the buffer curves inside compelling the support, first to release its hold to get out of the way, and then, after allowing the pin to effect its connection with the link, comes down itself on the link to keep it in its place. For simple efficiency it is good, but it is not fitted for English traffic.



The largest number of patents of any particular type is that which show an endeavor, by means of levers or cranks, to place the present chain or a long link (we shall see it is immaterial which it is) upon one wagon over and round the hook of another wagon. In some years there are two or three patents with this object, numbering in 14 years about the same total.

The promises of advantages in this direction were so evident that it is not surprising to find that several of this type have been well tested, others never tried at all, but there is one point upon which they fail.

On a curve 3¼ chains a wagon A is approaching another wagon B, to be attached to it. Now if we follow the line of A's drawbar until we arrive at the headstock of B we see that we miss B's drawhook centre by nearly half a foot,

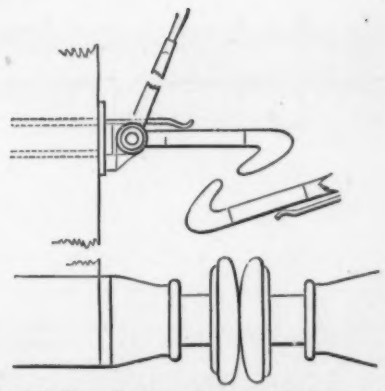


and it follows as a matter of course that if we reverse our curve we shall miss B's drawhook on the other side by a like difference, so that we have nearly a foot of loop necessary to connect. Now I must here tell you that there are many curves in shunting yards as sharp as 2½ chains; therefore, after allowing say an inch each side for increased loop for these sharper curves, and three inches for strength of arms, we have some 15 inches across as necessary to obtain a connection.

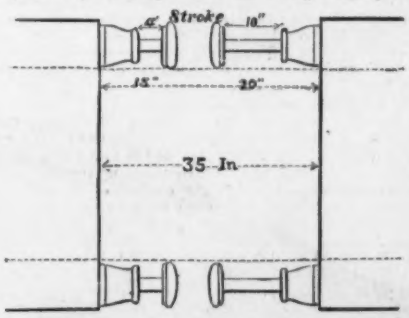
A glance at our list of requirements may suggest other points unfulfilled in this type.

I pass on to next diagram.

In this type we have a principle not unlike the Pullman car connection. Deep-sided vertical hooks all turned the same way; each of these hooks are made to yield to springs, so that on collision they each yield sufficiently to allow of the hooks to fly back and unite. This connection is automatic. The disconnection is accomplished by drawing back one or the other hook. This is a very taking coupling, and apart from the springs, which will never act for any length of time in railway work, it is simple, but there is one point in our list of requirements which it will never overcome: I mean different

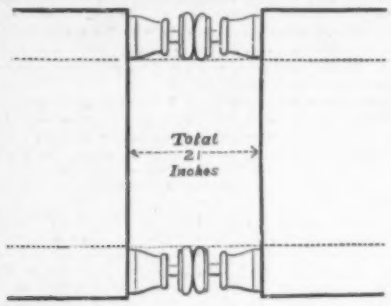


lengths of buffers. I must ask you to take for granted, that when you fit up a carriage which has a long buffer, you must



have your hook the right length of that carriage. Consequently, a vehicle with a 20-inch buffer and 10 inches of

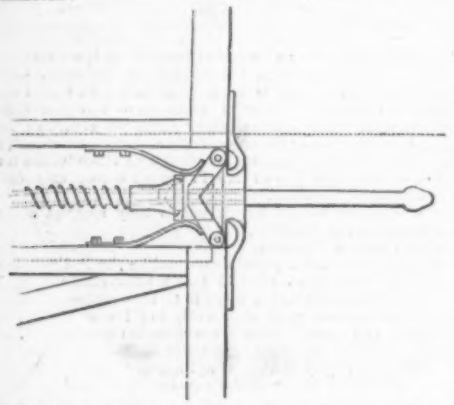
stroke has a hook, say 26 inches long, for we must allow for thickness of end, and also for sharp curves; this vehicle comes into contact with another, with a 15-inch buffer, also supplied with its proper length of hook, and this connection when on the run is all right, but suppose our engine suddenly



puts on the brake, or the vehicles are shunted against buffer stops, what will be the result?

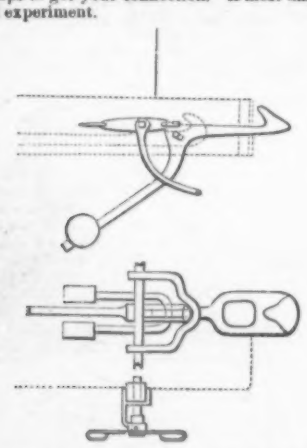
A's buffer is reduced to 10 } 21
B's " " 11 }

so that we have 21 inches of space in which to put 26, where must the other five go unless right through the opposite headstock?



In this type we have a truly ingenious connection. A round-pointed bar is placed in the jaws of an opening in the end of one carriage, which on being propelled against another similarly furnished, forces itself between the jaws of that carriage and is securely held by them. Upon the jaws being parted by a peculiar wedge, the rod is free to leave as it entered.

Now in this type the length of buffers again appears to prove an obstacle, but from a different aspect. In this instance the bar between two carriages must be double the length of one buffer. Now suppose we have twice the length of a fifteen-inch buffer, we have thirty inches in all, and we are short five inches of the connection distance necessary to attach to a twenty-inch buffer carriage. You must, therefore, either always have some different lengths of bar ready at hand, or when your bar is short must drive in your buffer against stops to get your connection. A most dangerous, and often fatal experiment.



One more illustration before we take up the working of English traffic.

This coupling has been very well tested. A flat-shaped iron plate with a hole in it, and a hook on its upper surface, is placed at one end of a long rod, which is hinged about half way on to the drawbar of the wagon, and at the opposite end of this rod is a weight to counterbalance the connection.

Both vehicles are fitted alike, and on approaching each other one plate slides under the other, thus lifting its own counterbalance up to the underframe of the carriage, until such time as it gets under the hole in the opposite plate, when the counterbalance forces the hook into it. By depressing the coupling, or by raising the weight, the coupling is freed.

The experience on working this coupling appears to be that the oscillation of the counterweights is liable to disconnect the coupling.

It may have been noticed that I have said nothing upon the tightening of passenger carriages in any one of these types. I have not done so for this reason; when the coupling has possessed tightening gearing, there are so many details to be entered into that they would have taken up too much time.

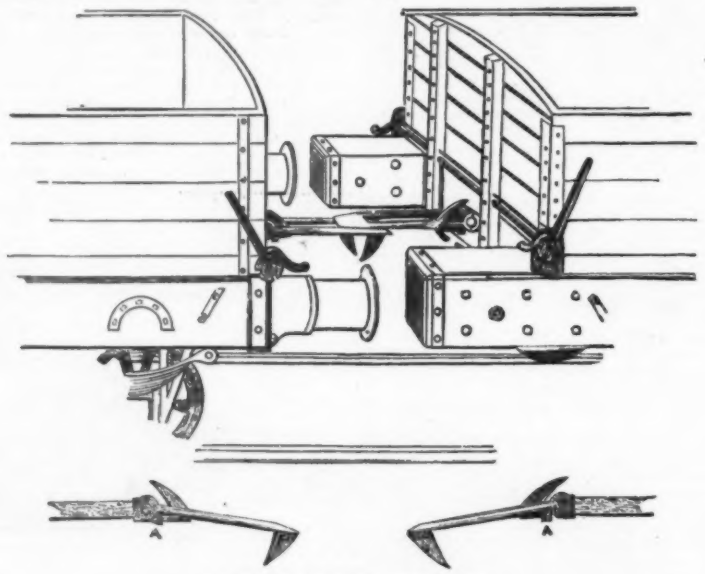
Let us now observe a few of the conditions of traffic, and endeavor to find out whether each of us here have not, as passengers, a very great interest in the adoption of improved couplings.

Imagine I am a goods' train guard. I leave London at noon with thirty-five loaded wagons. I ought to have started at 10.45; but, owing to my engine being busy shunting, and the shed goods not ready, I did not get away till 12. We ran on to Blackley, and arrived there at 12.50; put off three wagons, and took up two. Well, we get on Yellowby, Bluefield, and Redtown; of course, much behind time, but, by dint of working hard—I and my mates have been doing everything on the run, mind you—we have caught up our time by eleven minutes, and we did hope to make a good journey; but at Purple-road, where we are timed to take off and on for 15 minutes, it took us 78 minutes. And by this time we had run nearly a hundred miles, and, as you will see, we have lost two hours and twenty-two minutes, and, of course, had so much less spare time.

On the return journey we started in pretty good time, but yet, in consequence of delays in shunting, arrived in London an hour and a half late. Perhaps you may conclude that this is an unusual sample. It is a fiction, it is true; but, that I might satisfy myself, I timed one train four journeys in succession. This journey should have been performed in 7¼ hours, including stoppages. The best journey was done in 8¾, or 1½ late; the longest took 13 hours 50 minutes, or 6 hours and 20 minutes over time. Moreover, I was informed by a manufacturer in the midland counties that one train has been as many as twenty hours late more than once during the past winter.

Now you will understand that I bring forward these examples to show that, if despatch of traffic can be facilitated by automatic coupling, passengers, as well as the companies themselves, are very much interested in its adoption. Of this we may be sure, that a main element in the delay of any goods train is the overtime occupied in shunting and coupling. When we consider the conditions under which a countless array of passenger, goods, mineral, and empty trains in each day's traffic is worked, the conviction is forced upon us most strongly how wonderfully well the work is done. How traffic managers, inspectors, station-masters, pointsmen, signalmen, guards, shunters, and drivers (many of them at the risk of life and limb), each dependent on the other, so well carry on the traffic is a mystery It can only be by individual effort, which in an army, numbering as it does 300,000, becomes difficult to realise.

So far as we have been able to judge, the couplings we have already looked at do not sufficiently meet traffic requirements, but for the immediate purpose of my argument, I will assume one has been found, and that we have still a lion in the way, in the cost of its adoption. There are about 400,000 vehicles, more or less, owned by the companies, to be refitted, and with the cost, say, for example, at £5 per vehicle, we have a total



BROCKELBANK'S COUPLING.

expenditure of £2,000,000 to be divided amongst some 400 railways and branches.

Let us estimate the cost if gradually adopted. In about ten years from now, judging from past experience, every vehicle now running will have to be replaced, and in about the same period the traffic will increase 50 per cent., and even if we put the extra cost of automatic coupling to be as much as 30s. per wagon, this gives only £600,000 as the total cost of the improvement, and this expenditure will be spread over ten years—a bagatelle for railways. But you will say, how about traders' wagons? what do you say to them? Merely this, that as each wagon which enters a company's territory has to conform to the rules of that company as to the build, shape, and strength of materials, and pass a rigid inspection, the companies, on this point, are masters of the situation.

In the working expenditure of thirty-one millions there are two little items, of both of which passengers hear a good deal. The first is compensation to passengers and goods, which it is estimated, with its attendant expenses, cost the companies for the twelve months ending 30th June last, just one million of money.

Now without entering upon the large subject of reduction of cost of labor, which must result on the adoption of an improved coupling, it will be conceded that if only twenty collisions were prevented by the better dispatch of goods traffic thus gained, that in this item alone of compensation, and its attendant cost, a very handsome dividend on the expense even of immediate conversion would be realized.

Now I have touched upon saving of time, of labor, of collision, saving of life and limb, both of passengers and servants, and of reduction in cost of compensation for goods and passengers; but there is a subject on which I must touch: it is one which can hardly be ignored by employers of labor. I mean compensation to employés for death or injury received during work, and caused by the non-adoption of known appliances and conditions of safety in working.

I have but to direct your attention to this list, and we see death or injury received in one year.

Mines (say)	10,000
Railways, 1875	4,383
Boilers, (defective)	1,600
Factories	3,155
	19,138

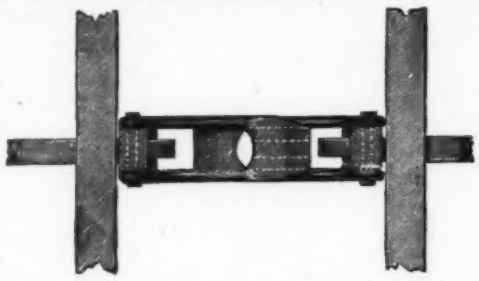
a total of for ten years say 191,380.

Now I could go into these figures and deal with the percentage of arms and legs lost, and point out how hundreds of little children fall victims in what are termed the peaceful pursuits of this merry England, but as that might be considered sensational I hold back; but after making good allowance for carelessness of work-people, nearly 200,000 every decade fall victims. Therefore, I say, no employer of labor can ignore this more than possibility.

I started the proposition that the problem for solution was to find a coupling that would fulfil the various conditions of English traffic.

The tenor of my remarks on this head have, I trust, shown that I by no means underrate the obstacles to be met. Consequently I do not venture to come before you with a crude idea for discussion, if I can demonstrate that I have overcome ninety-nine railway requirements, and should one other rise I think I may be confident I shall surmount that one.

As you may naturally suppose, very many people indeed have discussed the invention I submit, and the conclusion I arrived at is that only practical testing can convince. I will, therefore, run through the result of actual experiment.



Here are two arms forming a loop, flattened into a wedge-shaped end, at the underside of which is a hook. Upon coming together, either coupling runs over into the other. When slack each coupling rests on its support at an angle. Upon the tension of the draw-bars, each rises to a straight position, and the action on the run is ever varying on the sharpest curves, on inclines, with a light wagon or a train, with steady running or violent collision. I have never in actual practice succeeded in getting it unhooked.

To show you the certainty of connection, there are some in this room who have seen a heavy engine run sharply at a light passenger carriage standing alone on the line and hold it. Again on the run three or four wagons have been sent running away on an incline, and followed and brought back several times to a dead certainty by the engine and other vehicles sent after them.

But now let us see how it meets the general requirements.

Gradual Replacement.—On the present draw-bar of the vehicle I weld a square-shaped head, with a draw-hook or an eye for chain if desired. The chain of an approaching wagon can be placed on the hook, and the draw-bar action is complete.

Variety in Length of Buffers.—This is met by making my loop correspond to length of buffers.

Height of Vehicles.—I can secure connection at least seven inches of difference.

Loading and Unloading.—The uncoupling gear being entirely free from, and independent of, the coupling itself, is restricted to no position, angle, or place, and can be adjusted to suit every description of vehicle.

Weather.—As every joint is loose, and as the very working on the run of one other vehicle in connection leaves one coupling easy, no rusting can harm it.

Night Darkness.—This is the first time I have touched upon this requirement, but it is self-evident that the disconnection must be as sure with your eyes shut as wide open. In fact there is no necessity of looking after it if your wagon-buffers touch.

TIGHTENING APPARATUS.

To some persons this may appear complicated, but it is one of the simplest things in engineering. Here is the drawbar of a vehicle fitted with my coupling. I cut it in half, and make on this piece a right-handed screw, and on that a left-handed screw. I take a piece of iron about 8 or 9 inches long, and about 2½ square, and pierce it to receive these screws, and we have a continuous drawbar upon this square. I place a wheel, the revolution of which turns the bar, and either elongates or contracts its length; on elongation the coupling comes out from headstock, the little chains tighten, and the coupling lifts to release itself.

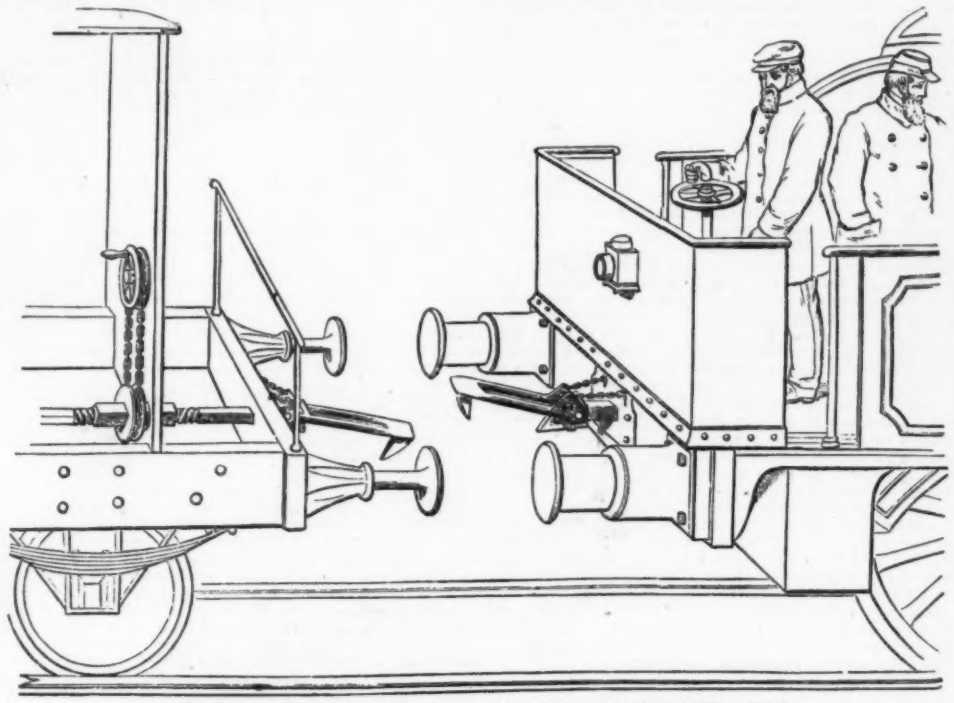
The first trial I ever attempted with this coupling was with the carriage apparatus, and I mounted the break-van, and with a train of five carriages behind me, signalled the engine to couple up on approaching the brake-coupling, and ran into that of the engine. Naturally enough great interest surrounded my actions, and I directed the driver to do two things

only, go on when I signalled, and stop when called upon. We started and got up a brisk pace, and without any warning to engine-driver, I unloosed and released the train from the engine by a few turns of the wheel; at the same moment I signalled go on, the engine flew away without its load; the driver, fearing something was wrong, at once shut off steam, and put on the engine-brake. The impetus of the train carried it gently up to the engine, and the connection was again complete.

The driver and stoker jumped down and commiserated with me upon the supposed failure of my apparatus, saying new attempts very often failed at first.

Slipping carriages, I know, is done daily; but I have never yet seen a coupling which you can tighten, loosen, and uncouple by one and the same action on the run.

One advantage I may be permitted to draw attention to. There need be no anxiety with this coupling lest an engine attached to a train should, through careless tightening, have to run loose for, say, fifty miles without being rectified. Either the guard or engine-driver, or both if necessary, can render the connection completely rigid.



BROCKELBANK'S ENGINE AND CARRIAGE TIGHTENING GEAR.

But you will remember I said that there was another item in working expenses reserved for consideration. That point was railway passenger duty, which, in 1874, cost the companies about £600,000. I offer a suggestion to the companies. The Railway Companies, we are repeatedly told, desire the repeal of this tax to enable them to provide increased facilities, such as workmen's trains. Suppose, instead of doing this they think of their own workmen, and appear before the Select Committee, now being appointed on the subject, with a proposition to this effect.

"As responsible employers we are deeply concerned at the awful sacrifice of life, and the injuries incurred by our servants annually in the working of traffic, but we can not ask our shareholders to incur the expenditure necessary to carry out the recommendations of the Board of Trade in improved couplings, without prospect of recouping themselves such outlay. But Parliament may aid us to carry out this improvement upon the following arrangement:

"We want five years in which to complete this alteration. During that period all passenger duty paid by us shall be lodged in the hands of trustees. On completion of alteration, all such money shall be repaid to us, and the duty itself from that date repealed entirely.

"Thus might this improvement be provided without any real cost whatever to the companies, and with the advantage that on repeal of the tax, not only would a handsome bonus be in hand, but dividends in future would be largely augmented. Would Parliament grant this? Undoubtedly, especially if it were enforced on its notice, that unless something is done 16,000 servants out of a total of 40,000 must be killed or injured in the next ten years over shunting operations, and falling off the vehicles."

I would draw attention to the fact that many of these couplings here before you have been tried on different lines in Scotland and England, and that, therefore, we must not for one moment assume that the companies have been doing nothing in this direction. Where they do appear to be wanting is the ability to understand the imperative necessity for united action on the matter. This is, as many of you know, an almost impossible position for them to assume; for, as we have seen in a figure, there is no union in the whole body.

FRIGHTFUL EFFECTS OF AN AVALANCHE.

THE *Journal de Paris* contains full particulars about the enormous snow avalanche which fell from the top of the Taillefer Mountain, Department of the Isere, causing havoc to the small village of La Grenoniere in the commune of Ornon. The village is situated on the sides of the mountain-peak, from the top of which the avalanche came thundering down the ridges of the mountain with such terrible force that by its violence the roofs of about twenty buildings, situated along the slopes of the little valley, right opposite the passage by which it descended, were partly lifted off and hurled away a long distance from the houses to the fields below. The remainder of the buildings were more or less damaged, chimneys, together with the slates of the roofs, blown off, the framework, the floors, and ceilings of the houses and barns cracked and damaged. The roofs carried off were entangled with each other in such a way as to make it impossible to move about in the midst of the wreck, presenting such a spectacle of devastation. Nothing like it has happened in the neighborhood for more than 60 years. The wind occasioned by the rolling avalanche, which engulfed the houses and lifted up the roofs, was just like the most terrible hurricane. The snow, in consequence of the hard-blowing wind, was crystallized in a moment and cast on to the walls. A layer of frozen and hardened snow covered the ravages and the ceilings of the houses deprived of their roofs. The rain was coming down fast and the snow falling without interruption as if wanting to complete the disaster, thus destroying the provisions and ruining the furniture of the poor stricken people. The huge mountain of snow caused by the avalanche remained lodged at the bottom of the gorge, rising to a prodigious height, at a distance of more than 200 yards below the village. It sounds almost incredible to have to relate, under such a catastrophe, that none of the inhabitants perished, or were even hurt, not any body, it seems, having been abroad in the streets of the village at the moment of the fall of the avalanche. The male population were to a great extent absent from their homes, as they are in the habit of hiring themselves out as laborers in the neighboring towns during the winter-time, and unable to come to the assistance of their families. The reader may therefore imagine the fright of the poor women and children, hearing the terrifying noise of the falling avalanche, and being eye-witnesses of the lamentable spectacle. The whole village of Grenoniere numbers only a hundred inhabitants and contains about thirty habitations. The disaster is considerable, and has reduced to the utmost misery the unfortunate villagers by having their houses thus ruined and covered with snow in the midst of winter.

The same journal records another catastrophe of a similar kind, but occasioned in this case by falling rocks and attended with fatal consequences, as follows: The small village of Puy-Guillon, commune of Fresselines, situated on the banks of a small mountain stream beneath the castle of the same name, and composed of a water-mill and several houses, is separated from the rocky mountain by a narrow road only, that, cut out in the rocks, leads from Fresselines to the castle above. In consequence of the torrents of rain that fell incessantly for several days, an enormous mass of rock got detached from the mountain, sliding down with a frightful crash, and demolishing in its downward flight several houses. One woman and a young girl were killed on the spot. Several were injured, one very badly crushed and wounded; several had very narrow escapes. The inanimate remains of the victims were transported to Fresselines, where, the day after the sad event, the funeral took place, assisted by a great concourse of the neighboring population. The remaining houses of the small village had in the meantime all been deserted, as it was evident that another large mass of rock had been undermined by the rains, threatening to detach itself in the same way from the mountain-top, and inducing the population to remove from the dangerous proximity.

INDELIBLE PRINTING INK.

D. M. MARSHALL, Columbia City, Ind., states that if to one pound of printer's ink one ounce of dilute carbolic acid is added and mixed thoroughly, the ink thus prepared is rendered indelible. This ink is chiefly intended for cancelling postage-stamps.

[Condensed from La Nature.]

FOSSIL FOOTPRINTS.

THE reconstruction of the skeletons of entire animals from the data deduced from a single bone, has justly been regarded as one of the marvels of science; still more wonderful, however, is the determination of the nature and characteristics of extinct creatures by the footprints which they have left upon the soil, soft in their day, but now hardened into stone. An immense number of prehistoric animals have been discovered from these vestiges, which in many instances furnish us all the evidence extant that such beings ever existed upon the earth. It is by such testimony that paleontologists are enabled to assert the existence of birds at the period when the red sandstone of Massachusetts was consolidated—long before the era when lived any bird, the actual remains of which have been found.

The mode in which fossil footprints were produced is rendered clear by observation of that which now occurs on the sea-beach or on the shore of any body of water. M. Marcou has obtained on the shores of the Bay of Fundy slabs of clay, on which are imprinted bird-tracks and drops of rain; and in the French Museum of Natural History, where the above have been deposited, is a Roman brick showing clearly the impress of a sheep's foot. The identity of these specimens with those

FIG. 1.—FOOTPRINTS OF THE *CHEIROTHERIUM* IN TRIASSIC SANDSTONE, $\frac{1}{12}$ NATURAL SIZE.

extracted from geological strata, leave no doubt as to the unity of the cause to which all are due.

The most ancient fossil footprints now known belong to the Laurentian period, and are attributed to crustaceans. The *Clematichnites Wilsoni* collected in Canada may be cited as an instance. The Devonian rocks of England have furnished tracks which are recognized as those of land tortoises. It is certain that they were produced by a four-footed animal, and their rounded form, destitute of well-marked toes, are further evidence of the correctness of the derivation above attributed. In America strata of the same age have furnished Mr. Lea tracks having the character of those of the saurians, and in particular resembling the prints left by the alligator. That author, however, points out various characteristics which appear to him to justify the establishment, under the name of *Sauropus*, of a new genus, of which up to the present no vestiges have been found. A quadruped has left footprints on certain strata of the carboniferous age in Pennsylvania, and this animal, according to Lyell, is allied to the *Cheirotherium*, to which we shall allude further on. It placed its feet, however, at a much greater transverse distance apart than the *Cheirotherium*, and had the remarkable characteristic of great toes, or thumbs, placed on the external side of the feet or hands. No other known being exhibits like physical construction.

FIG. 2.—IMPRESSION OF POSTERIOR FOOT OF THE *CHEIROTHERIUM*, $\frac{1}{4}$ NATURAL SIZE.

It is, however, in the trias, and especially in the variegated sandstone, that the most numerous, clearest, and best studied footprints are collected. Figs. 1 and 2 exhibit those of the *Cheirotherium* (the name signifies "animal with hands," a manifestly appropriate designation), and the rocks are found in various localities of England and Germany. These imprints are remarkably clear. The five fingers are disposed almost exactly as in the hand. The thumb is separated from the other fingers, and the impression of the phalanges, of the nails, and even of the rugosities of the skin, are clearly shown. It will also be observed from Fig. 1 that the anterior members were much smaller than the posterior ones.

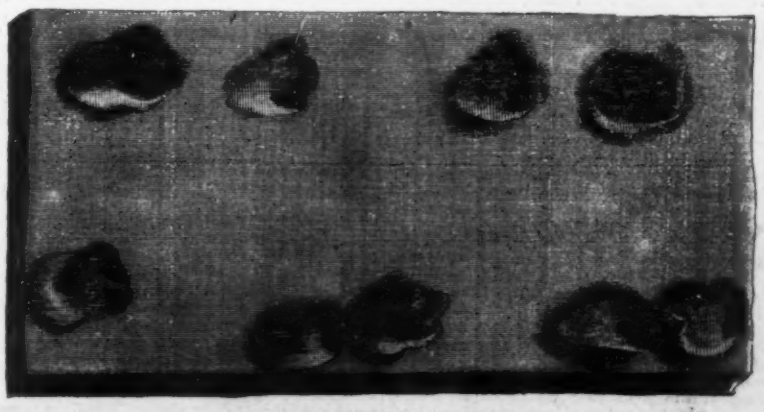


FIG. 3.—FOOTPRINTS OF TORTOISE.

Naturalists have long hesitated over definitely affirming the zoological nature of the *Cheirotherium*. Duncan, Brown, Weigmann, and Humboldt classed it among the mammifers, and even considered it a didelphys. Others, Lenck, De Munster, Kaup, and Owen, consider it a batrachian. Owen has even remarked that through the dimensions and various details of organization the *Cheirotherium* so closely resembles the *labyrinthoden* that the two may be identified as the same. The latter, designated by Jaeger as *Salamandroides giganteus*, is known by many well-preserved remains, including an entire head, teeth, many bones, etc., found in the triassic strata of Wurtemburg. All the characteristics of this strange animal tend to ally it to the batrachians as well as to the true reptiles.

The sandstone bearing the footprints of the *Cheirotherium* shows two peculiarities. First, the tracks are not concave, but appear in relief; and second, as shown in Fig. 1, there is a network of small ridges formed among them. From these appearances it is deduced that the *Cheirotherium* never walked on the sandstone itself, but on some soft clayey bed, upon which its steps left hollow prints. Subsequently fine sand, driven by the wind, filled all the cavities, and future infiltration of a mineral cement converted the loose particles into sandstone, thus producing imperishable "castings" of the footprints. This is further proved by the latter always appearing on the lower sides of the slabs as they are exhumed.

The ridges have an analogous origin, and may be considered as representing the "fossil sun" of the triassic epoch. The clayey bed passed over by the reptile very probably remained long exposed to the sun's heat. As it dried it cracked, and the sand entering the fissures became moulded in their form as it did in that of the footprints.

Fig. 3 represents tracks left on the red triassic sandstone of the quarries of Corn Cockle Muir, Dumfries, Scotland. They are produced by a four-footed animal, and from their peculiar shape they are attributed to land tortoises. In Fig. 4 are represented bird tracks found on inclined layers of red

FIG. 4.—FOOTPRINTS OF BIRDS.

sandstone, located in the Connecticut Valley, some 3,200 feet above sea level. Prof. Hitchcock points out that the relation of the length of leg to the size of the feet shows that these ancient birds must have been runners, and he has classified the creatures as *Ornithicnites*. Coprolites found in the same localities contain urea sufficient to confirm the opinion that they are due to birds, and grains likewise discovered in these fossil dejecta prove the birds to have been granivorous.

FLORA OF NEW-CALEDONIA.

THE island of New-Caledonia, belonging to the groups classed by geographers under the term of Australasia, is situated between the parallels 20 and 23.30 south latitude; longitude between 164 and 167, east of Greenwich. Its length is about 220 miles, its breadth 30, and its direction N.W. and S.E. Its surface is mountainous, rising in the interior to a height exceeding 6000 feet. The inhabitants are of the same race as the Papuans, or natives of New-Guinea. A former classification of the islands of the South Seas classed certain groups as Melanesian, from the darker color of their inhabitants as compared with the Malays and with the inhabitants of New-Holland. And it may be observed that the principal islands in the Melanesian groups and the groups themselves usually lie in the same diagonal position to the equator, N.W. and S.E., as if their origin were due to the same geological movement. The geological formation and the flora of New-Caledonia, as also those of the neighboring groups and of New-Guinea, are much more closely allied to the Melanesian Islands than to New-Holland. And the original inhabitants are a decidedly lower race than the natives of that "fifth continent."

New-Caledonia was discovered in 1774 by Captain Cook. In the suite of this navigator was John Reinhold Forster, a Prussian naturalist of distinguished acquirements. Forster took with him his son. The condition of his appointment as naturalist of Cook's expedition was that he should publish no account of the voyage; but this condition was evaded by a minute account published in his son's name. In 1792 Labillardière, who had accompanied d'Entrecasteaux in his voyage in search of Lapeyrouse, published a work on the flora of New-Holland and New-Caledonia. Both authors furnished highly valued notes for the time at which they were published. From that time until nearly to the present, few additions were made to the scientific knowledge of New-Caledonia. The shores of the island and its neighbors were visited by few other adventurers than the searchers for santalum, or sandal-wood, and *beche-de-mer*. The sandal-wood is in large request in the East as a perfume and a medicament. The beche-de-mer is a sea-slug (Holothuria) in great favor in China as an ingredient in soup. The commerce, especially in the latter article, which never enters our home invoices, is of no little consequence, and many of the smaller islands of Oceanica are visited not only by the Malays and Chinese, but by European and American vessels, to collect *beche-de-mer*.

French missionaries of the Roman Church established themselves in New-Caledonia about the year 1843. They did so at the peril often of their lives, as the natives were cannibals, and in other respects debased and treacherous. The assassination of a boat's crew belonging to a French vessel in 1853, led to the occupation of the island by the French. The vessel was lying off the point near which Captain Cook landed in 1774, and a boat with two officers and fifteen men was dispatched to make observations. The party landed on a small island, supposing it to be uninhabited, and stepped on shore without the slightest apprehension of danger. A hundred savages rushed from their concealment in the bushes, armed with clubs, arrows and hatchets; and before the unfortunate Frenchmen could rally, they were massacred. Immediate vengeance was taken by the French commander, Comte d'Harcourt, a number of the natives fell, and their villages and crops were destroyed. Upon the report of this transaction to the French Government, a force was dispatched to take definitive possession of the island of New-Caledonia and its dependencies. On the 24th of September, 1853, Rear Admiral Febvrier-Depointes displayed the French flag at the spot where the massacre of the year before took place.

The efforts of the French Government, which has been ever since in possession, have extinguished cannibalism, or nearly so; and observation has thrown much light upon the past customs of the aborigines. A palliation for their horrid custom of man-eating is given in the fact that, except fish, the island, in its original condition, furnished no animal food. It is said that one of their chiefs, dining one day on board of a French ship, manifested great satisfaction at the taste of roast veal. "One might think it was man!" he said, smacking his lips. On being reprimanded for a taste so disgusting as that for human flesh, he answered: "You have animals for food, we have not; and when we have eaten man's flesh we are strong and brave." At the harvests—for these islanders had harvest seasons and grand feasts, with solemn rites after their fashion—the smallest pretext served for a war between different tribes, that the killed in war, and the captured and killed afterward, might furnish viands for the horrid festival. A "harvest home," with abundance of such provision, was a point of pride with the natives. Only the chiefs could partake unless the provision were very abundant; and the women were always forbidden to share in the orgies. This was not a compliment to their sex, but part of a system which treated women as only fit for labor and degradation.

But these notes of the habits and character of the natives are but repetitions of what has been published over and again. The matter of chief interest to-day is to present some of the remarkable natural features and products of the island. Formerly pursued under great difficulties and dangers, the explorations of the French scientific men are now conducted at leisure and with method, and they declare that there are few points on the globe which present so much interesting and attractive matter to the naturalist. Very interesting papers on the natural history of New-Caledonia have been presented to the French Academy of Sciences by M. Ad. Brongniart, Dean of the Section of Botany.

Of the surface of New-Caledonia and its neighboring islands, it is said that hardly one-fourth is capable of cultivation. As on all mountainous islands of volcanic formation, the plains and valleys alone are cultivable. The mountain torrents sweep the soil and fertilizing matter down into the plains, and the rocky elevations are left bare, except in their fissures and depressed parts, which have a special vegetation, a spontaneous flora. Here are found indigenous varieties of the Myrtle, the Protea family, the Epacridaceæ and the Casuarina, or beef-wood, so called from its red color. Lower down grow forests of great pines, the *Dammara* and *Araucaria*, common to the Southern regions.

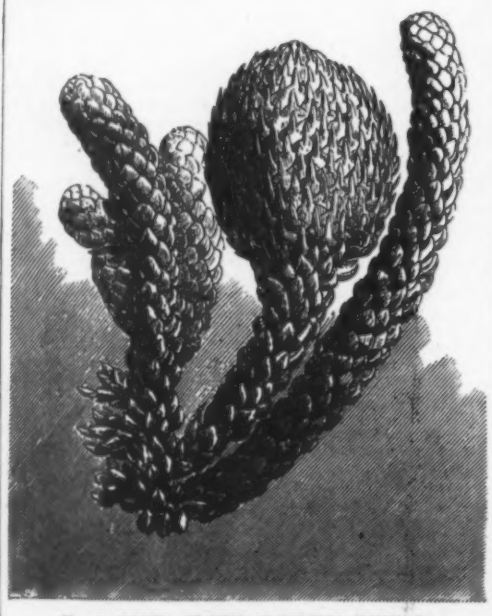


FIG. 1.—CONES OF THE ARAUCARIA MONTANA.

Ordinarily ferns grow in low situations. In New-Caledonia, where the clouds bathe the mountain tops in vapor, are found a great variety of ferns, peculiar to their situation, and some of tree-like size. Ferruginous earth abounds in New-Caledonia. In some places the soil is clay impregnated with oxide of iron. At the time of the occupation of the island by the French, it was reported that gold was among its products; but that expectation has not been confirmed. The vegetation of the ferruginous soil is scanty. The alluvium washed down from the mountains furnishes a productive though not deep mould. Under this is found a stratum of gravel or fossil coral, which extends out from the shores of the island in formidable reefs.

The base of the diet of the islanders is vegetable matter, consisting principally of yams. The variety most cultivated is the *Dioscorea Alata*, which is a species common to the tropical islands. It is from eight to ten months in coming to maturity, and weighs from twelve to thirty pounds. Of the yam there are about half a dozen varieties. Two or three species of the arrow-root family are also found, but the yam is the great staple. Besides these roots, the fruit of the banana and cocoa enter largely into daily consumption. The sugar-cane would seem to be indigenous to the island. The natives recognize some forty varieties. The islander never moves without a piece of cane in his hand, chewing as he walks, and tossing the remains away, thus starting everywhere new tufts of the much-prized though common plant.

Other useful plants and trees are of secondary importance to a sluggish people who scarce need vestments. But many are employed in their daily wants. The light wood of the Hibiscus is used to obtain fire by friction. The bark of the paper mulberry is used for girdles and head ornaments; and the same use is made of the *Thespesia populnea*. The bark of a climbing leguminous plant, the *Pachyrrisus angulatus*, serves, by its tenacity, for making fishing nets. Although the forests are searched for the hard wood of certain myrtles, and of the *Casuarina*, or beef-wood, for the manufacture of arms, these trees are of chief value in the construction of houses. One of the trees most useful in New-Caledonia is a species of myrtle, called by the natives the Ninouli (Melaleuca viridiflora). It is little different from the *M. leucadendron* of New Holland. The Ninouli covers considerable spaces in New-Caledonia. Its growth indicates land fitted for pasturage; its wood is at once tough and easily worked; its bark, supple and felt-like, is very useful in the construction of houses and canoes, and is burned in lieu of torches. Sanitary properties are claimed for it by the natives, similar to those possessed by the *Eucalyptus*, another myrtle recently introduced into Europe and this country. Speaking of the *Eucalyptus*, it is curious to remark that, though over a hundred varieties of this tree are found in New-Holland, in New-Caledonia, though on the same parallel and only three hundred leagues distant, not a specimen of the Eucalyptus has been identified.

A succession of eminent French botanists have explored New-Caledonia, and from their rich collections M. Brongniart has compiled some curious results. Very rarely are precisely the same species of plants found in New-Caledonia and New-Holland. Plants are noted of the same families; but analogy is found, and not identity. Where one site abounds in a variety of species, the other will have a bare specimen. Besido the *Eucalyptus* mentioned above, the family of Acacias may be mentioned. In New-Holland, three hundred species are found; in New-Caledonia only two. Among the myrtles, the genera *Fremya* and *Clasia* have, in New-Caledonia, each six or eight indigenous species; while the species abundant in New-Holland are not native in New-Caledonia. And so of many other genera and species, the specimens most abundant in New-Holland are scarcely known in New-Caledonia. The Casuarina, the melancholy leafless tree of Australia and South Africa, has only a few types in New-Caledonia. European botanists have noted the strange appearance which all native vegetation presents in the Australasian region; as if nature had sentenced all indigenous vegetation to contraction in foliage. The acacias, for instance, lose the beautiful leaflets which surround the leaf-stem in India and Africa; and the petiole or leaf-stem, prodigiously developed, takes the functions of the leaf, assuming the form known to botanists under the term Phyllium, or Phyllodium.

One might describe New-Caledonia as a land of accretions, to which the neighboring islands and the continent of Australia have sent partial representatives of their vegetation, analogous but scarcely ever identical. These resemblances may be traced between New-Caledonia and the Polynesian groups, and even with South Africa. The Cape of Good Hope long boasted the possession of a unique species of the sassafras (*Cunonia capensis*). Five analogous varieties have been found in New-Caledonia. Of the palm family, some twenty new varieties appear in the island; of the screw pine (*Pandanaceæ*) and Euphorbia, about as many; and the fungi, the mosses, and the ferns present a like array of new species.

Dr. Robert Brown, the distinguished British botanist, whose work on the botany of Australia was published in 1814, followed the natural order of Jussieu. He gave to Australia one-eighth of the species of known plants, as peculiar to that region, and subsequent discoveries have only increased the number of species, without disturbing the relative proportion. The New-Caledonia flora, though analogous to that of New-Holland and other tropical regions, is (as above stated) not identical with it. The study of the flora of these regions is curious, rather than profitable, as very little has been added, in any department, to the wealth of the world by it. Following the natural order of Jussieu, M. Brongniart gives to the first great family, the cryptogamous (flowerless) plants, 965 species in New-Caledonia, and to the other, the phanerogamous (flowering) plants and trees, 800 species. Some few of the varieties on the island are striking for their beauty, though the greater part are rather curious and, at the first view, anomalous. The following engraving of a species of the Tilia or Linden family, with bell-flowers, is the representation of one of the attractive specimens:

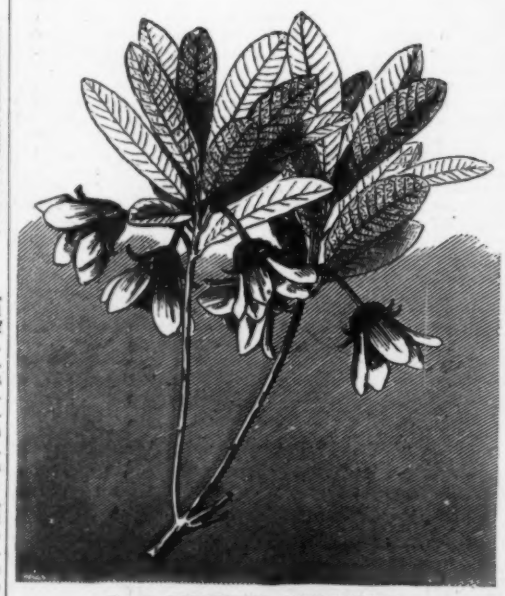


FIG. 2.—DUBOUZETIA CAMPANALUTA.

The general aspect of vegetation in these last-discovered corners of the earth is not cheerful. Leaves have a fashion of presenting their edges to the trunk or branch; some shrubs are without leaves. There are other features and particulars which make it seem as if the geological convulsion which threw these islands to the surface, gave their future vegetation a twist also. But, though to live on the natural products of the islands would restrict the fare very much, it is pleasant to know that they are highly susceptible of cultivation, and give good crops of exotic plants.